# 10 Physical uplink control channel procedures

If the UE is configured with *shortTTI*, PUCCH in this clause refers to SPUCCH defined in [3] if the HARQ-ACK is sent in response to PDSCH scheduled by DCI format 7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G or scheduling request is sent on resources configured by higher layer parameter *sr-slotSPUCCH-IndexFH or sr-slotSPUCCH-IndexNoFH or sr-subslotSPUCCH-Resource* for slot/subslot-based transmissions, unless otherwise noted.

If the UE is not configured with *shortTTI* or the UE is configured with *shortTTI*, and UCI is to be transmitted in a subframe, the term 'subframe/slot/subslot' or 'subframe/slot' refers to a subframe in this clause.

If the UE is configured with *shortTTI*, and UCI is to be transmitted in a slot, the term 'subframe/slot/subslot' or 'slot/subslot' or 'subframe/slot' refers to a slot in this clause.

If the UE is configured with *shortTTI*, and UCI is to be transmitted in a subslot, the term 'subframe/slot/subslot' or 'slot/subslot' refers to a subslot in this clause.

If the 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 the 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 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.

A UE is not expected to be configured with PUCCH on a LAA SCell.

Throughout this clause,

- if the UE is configured with higher layer parameter *shortProcessingTime* and the corresponding PDCCH with CRC scrambled by C-RNTI is in the UE-specific search space*, * and **otherwise,

- if the UE is configured with higher layer parameter *shortTTI* and the corresponding PDCCH/SPDCCH with DCI format 7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G is detected in a subslot, ** is determined based on higher layer parameter *min-proc-TimelineSubslot* from **.

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 configured with EN-DC, and if serving cell frame structure type 1, and if the UE is configured with *tdm-PatternConfig2* for the serving cell, or

- if the UE configured with EN-DC, and if primary cell frame structure type 2 and if the UE is configured with *tdm-PatternConfig2* for the primary cell, and if the UE configured with more than one serving cells, and if secondary serving cell frame structure type 2 with different UL/DL configuration than the primary cell, or if secondary serving cell is frame structure type 1,

- the UE shall apply the procedures described in this clause assuming FDD-TDD and primary cell frame structure type 2 with "UL/DL configuration" given by *tdm-PatternConfig/tdm-PatternConfigNE-DC*/*tdm-PatternConfig2* and serving cell frame structure type 1. The UE shall apply an offset value given by *harq-Offset-r15*/*harq-Offset-r16* to the subframe index in the UL/DL configuration when applying the procedures in this clause.

- if the UE configured with EN-DC, and if primary cell frame structure type 2 and if the UE is configured with *tdm-PatternConfig2* for the primary cell, and if the UE configured with more than one serving cells, and if secondary serving cell has the same UL/DL configuration as the primary cell,

- the UE shall apply the procedures described in this clause assuming the UE is configured with more than one serving cell with "UL/DL configuration" given by *tdm-PatternConfig2* and serving cell frame structure type 2. The UE shall apply an offset value given by *harq-Offset-r16* to the subframe index in the UL/DL configuration when applying the procedures in this clause.

- 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 configured with EN-DC, and if the UE does not indicate a capability for dynamic power sharing (as specified in [17]), and if the UE is configured with *tdm-PatternConfig2* for the serving cell, the UE is not expected to transmit any uplink physical channel or signal in the serving cell on subframes other than the offset-UL subframes, where the offset-UL subframes are determined by applying the offset value to the subframes denoted as uplink in the UL/DL configuration.

- The UE is configured by higher layers to use PUCCH format 3/4/5 for transmission of HARQ-ACK.

- if the UE configured with EN-DC, and if primary cell frame structure type 2 and if the UE is configured with *tdm-PatternConfig2* for the primary cell, and if the UE only receives the DCI format with value of the DAI field equal to '1' and/or only receives a PDSCH transmission on the primary cell where there is not a corresponding PDCCH/EPDCCH detected, the UE shall use PUCCH format 3 for transmission of HARQ-ACK with the PUCCH resource corresponding to the 1st PUCCH resource value configured by the higher layers.

- The UE shall use  and  (defined in Clause 10.1.3.2.2/10.1.3.2.3/10.2.3.2.4) when applying the procedures described in Clause 10.1.3.2.2/10.1.3.2.3/10.2.3.2.4.

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

If a non-BL/CE UE is configured for a single serving cell and is not configured for simultaneous PUSCH and PUCCH transmissions, then in subframe/slot/subslot  uplink control information (UCI) shall be transmitted

- on subframe-PUCCH using format 1/1a/1b/3 or 2/2a/2b if the UE is not transmitting PUSCH

- on slot-PUCCH using format 1/1a/1b/3/4 if the UE is not transmitting PUSCH and the UE is configured with higher-layer parameter *ul-STTI-Length*='slot'

- on subslot-PUCCH using format 1/1a/1b/4 if the UE is not transmitting PUSCH and the UE is configured with higher-layer parameter *ul-STTI-Length=*'*subslot*'

- on PUSCH if the UE is transmitting PUSCH in subframe/slot/subslot  unless the PUSCH transmission corresponds to a Random Access Response Grant or a retransmission of the same transport block as part of the contention based random access procedure, in which case UCI is not transmitted

- if the UE is semi-persistently scheduled for subframe-PUSCH transmissions of a transport block spanning consecutive PUSCH transmissions (including subframe *n*)corresponding to an SPS configuration with higher layer parameter *totalNumberPUSCH-SPS-UL-Repetitions,* in which case periodic CSI is not transmitted

If the UE is configured for a single serving cell and simultaneous PUSCH and PUCCH transmission, then in subframe/slot UCI shall be transmitted

- on subframe-PUCCH using format 1/1a/1b/3 if the UCI consists only of HARQ-ACK and/or SR

- on slot-PUCCH using format 1/1a/1b/3/4 if the UCI consists only of HARQ-ACK and/or SR and the UE is configured with higher-layer parameter *ul-STTI-Length*='slot'

- on subslot-PUCCH using format 1/1a/1b/4 if the UCI consists only of HARQ-ACK and/or SR and the UE is configured with higher-layer parameter *ul-STTI-Length=*'sub*slot*'

- on PUCCH using format 2 if the UCI consists only of periodic CSI

- on PUCCH using format 2/2a/2b/3 if the UCI consists of periodic CSI and HARQ-ACK and if the UE is not transmitting PUSCH

- on PUCCH and PUSCH if the UCI consists of HARQ-ACK/HARQ-ACK+SR/positive SR and periodic/aperiodic CSI and if the UE is transmitting PUSCH in subframe/slot/subslot *n*, in which case the HARQ-ACK/HARQ-ACK+SR/positive SR is transmitted on subframe-PUCCH using format 1/1a/1b/3 or format 1/1a/1b/3/4 if the UE is configured with higher-layer parameter *ul-STTI-Length='slot'*, or format 1/1a/1b/4 if the UE is configured with higher-layer parameter *ul-STTI-Length='subslot*'*,* and the periodic/aperiodic CSI transmitted on PUSCH unless the PUSCH transmission corresponds to a Random Access Response Grant or a retransmission of the same transport block as part of the contention based random access procedure, in which case periodic/aperiodic CSI is not transmitted

- on PUSCH if the UCI consists of HARQ-ACK/HARQ-ACK+SR/positive SR and if the UE is configured with higher-layer parameter *ul-STTI-Length=*'*subslot*'*,* and if the PUSCH transmission corresponds to semi-persistent scheduling of subslot-PUSCH (i.e. higher layer parameter *sps-ConfigUL-sTTI-r15* is configured, see 3GPP TS 36.331 [9]) and with a configured periodicity of 1 subslot (i.e. *semiPersistSchedIntervalUL-STTI-r15* set to *sTTI1*) and with *DMRS-pattern* field in the related DCI format equal to '10' (i.e., see Table 5.5.2.1.2-2 of 3GPP TS 36.211 [3]), in which case PUCCH is not transmitted

If the UE is configured with more than one serving cell and is not configured for simultaneous PUSCH and PUCCH transmission, then in subframe/slot/subslot  UCI shall be transmitted

- on subframe-PUCCH using format 1/1a/1b/3/4/5 or 2/2a/2b if the UE is not transmitting PUSCH

- on slot-PUCCH using format 1/1a/1b/3/4 if the UE is not transmitting PUSCH

- on subslot-PUCCH using format 1/1a/1b/4 if the UE is not transmitting PUSCH

- on PUSCH of the serving cell given in Clause 7.2.1 if the UCI consists of aperiodic CSI or aperiodic CSI and HARQ-ACK

- on primary cell PUSCH if the UCI consists of periodic CSI and/or HARQ-ACK and if the UE is transmitting on the primary cell PUSCH in subframe  unless the primary cell PUSCH transmission corresponds to a Random Access Response Grant or a retransmission of the same transport block as part of the contention based random access procedure, in which case UCI is not transmitted

- on primary cell subframe-PUSCH if the UCI consists of periodic CSI and/or HARQ-ACK and if the PUSCH in subframe cid:image002.png@01D3F938.ED598C70  is semi-persistently scheduled as part of consecutive PUSCH transmissions of a transport block associated with an SPS configuration with higher layer parameter *totalNumberPUSCH-SPS-UL-Repetitions,* in which case periodic CSI is not transmitted.

- on PUSCH of the secondary cell (other than an LAA SCell) with smallest *SCellIndex* if the UCI consists of periodic CSI and/or HARQ-ACK and if the UE is not transmitting PUSCH on primary cell but is transmitting PUSCH on at least one secondary cell (other than an LAA SCell)

If the UE is configured with more than one serving cell and simultaneous PUSCH and PUCCH transmission, then in subframe/slot/subslot  UCI shall be transmitted

- on subframe-PUCCH using format 1/1a/1b/3 if the UCI consists only of HARQ-ACK and/or SR

- on slot-PUCCH using format 1/1a/1b/3/4 if the UCI consists only of HARQ-ACK and/or SR

- on subslot-PUCCH using format 1/1a/1b/4 if the UCI consists only of HARQ-ACK and/or SR

- on subframe-PUCCH using format 4/5 if the UCI consists only of HARQ-ACK and/or SR and/or periodic CSI

- on PUCCH using format 2 if the UCI consists only of periodic CSI corresponding to one serving cell

- as described in Clause 10.1.1, if the UCI consists of periodic CSI and HARQ-ACK and if the UE is not transmitting on PUSCH

- on PUCCH and primary cell PUSCH if the UCI consists of HARQ-ACK and periodic CSI and the UE is transmitting PUSCH on the primary cell, in which case the HARQ-ACK is transmitted on PUCCH using format 1a/1b/3 and the periodic CSI is transmitted on PUSCH unless the primary cell PUSCH transmission corresponds to a Random Access Response Grant or a retransmission of the same transport block as part of the contention based random access procedure, in which case periodic CSI is not transmitted

- on PUCCH and PUSCH of the secondary cell (other than a LAA SCell) with the smallest *SCellIndex* if the UCI consists of HARQ-ACK and periodic CSI and if the UE is not transmitting PUSCH on primary cell but is transmitting PUSCH on at least one secondary cell, in which case, the HARQ-ACK is transmitted on subframe-PUCCH using format 1a/1b/3 and the periodic CSI is transmitted on PUSCH

- on PUCCH and PUSCH if the UCI consists of HARQ-ACK/HARQ-ACK+SR/positive SR and aperiodic CSI in which case the HARQ-ACK/HARQ-ACK+SR/positive SR is transmitted on subframe/slot-PUCCH using format 1/1a/1b/3 or on slot-PUCCH using format 1/1a/1b/3/4 or on subslot-PUCCH using format 1/1a/1b/4 and the aperiodic CSI is transmitted on PUSCH of the serving cell given in Clause 7.2.1

- on PUSCH if the UCI consists of HARQ-ACK/HARQ-ACK+SR/positive SR and if the UE is configured with higher-layer parameter *ul-STTI-Length=*'*subslot*'*,* and if the PUSCH transmission corresponds to semi-persistent scheduling of subslot-PUSCH (i.e. higher layer parameter *sps-ConfigUL-sTTI-r15* is configured, see 3GPP TS 36.331 [9]) and with a configured periodicity of 1 subslot (i.e. *semiPersistSchedIntervalUL-STTI-r15* set to *sTTI1*) and with *DMRS-pattern* field in the related DCI format equal to '10' (i.e., see Table 5.5.2.1.2-2 of 3GPP TS 36.211 [3]), in which case PUCCH is not transmitted

For a BL/CE UE, uplink control information (UCI) shall be transmitted in subframe 

- on PUCCH using PUCCH formats 1, 1a, 2, 2a for FDD and a UE configured or assumed in CEModeA if the UE is not transmitting PUSCH in subframe , or if the UE is transmitting PUSCH in subframe and the number of PUCCH repetitions defined for the UCI in [3] is larger than 1, or if the UE is transmitting PUSCH in subframe and the indicated PUSCH repetition number in DCI format 6-0A/6-0B is larger than 1, or if the UE is transmitting PUSCH in subframe  and the PUSCH resource assignment is using uplink resource allocation type 5

- on PUCCH using PUCCH formats 1, 1a, 1b, 2, 2a, 2b for TDD and a UE configured or assumed in CEModeA if the UE is not transmitting PUSCH in subframe, or if the UE is transmitting PUSCH in subframe and the number of PUCCH repetitions defined for the UCI in [3] is larger than 1, or if the UE is transmitting PUSCH in subframe and the indicated PUSCH repetition number in DCI format 6-0A/6-0B is larger than 1, or if the UE is transmitting PUSCH in subframe  and the PUSCH resource assignment is using uplink resource allocation type 5

- on PUCCH formats 1, 1a for a UE configured or assumed in CEModeB

- on PUSCH if the UE is transmitting PUSCH in subframe  and the number of PUCCH repetitions defined for the UCI in [3] is equal to 1, the indicated PUSCH repetition number in DCI format 6-0A/6-0B is equal to 1 and the PUSCH resource assignment is not using uplink resource allocation type 5 unless the PUSCH transmission corresponds to a Random Access Response Grant or a retransmission of the same transport block as part of the contention based random access procedure, in which case UCI is not transmitted.

If the UE is configured with more than one serving cell, then reporting prioritization and collision handling of periodic CSI reports of a certain PUCCH reporting type is given in Clause 7.2.2.

If a UE is not configured with simultaneous transmission of PUSCH and PUCCH, and if a subframe-PUSCH and at least two slot/subslot-PUCCHs or two slot/subslot-PUSCHs are collided within the same subframe on a given carrier, prioritization and collision handling between PUSCH and PUCCH spanning the same number of symbols (given in this clause) is first applied, followed by prioritization and collision handling of PUSCH and PUCCH spanning different number of symbols (given in this clause).

A UE transmits PUCCH only on the primary cell.

A UE is configured by higher layers to transmit PUCCH on one antenna port  or two antenna ports . PUCCH format 4 and PUCCH format 5 can only be transmitted on one antenna port .

For a serving cell, and a UE configured with higher layer parameter *shortTTI*, in case of a collision between a subframe-PUCCH and slot/subslot-PUCCH in a subframe, the subframe-PUCCH transmission is dropped. If the slot/subslot-PUCCH coincides with a SR transmission instance, SR that was prepared as part of the subframe-PUCCH transmission is transmitted on the slot/subslot-PUCCH in case SR is not already prepared for the slot/subslot-PUCCH. Otherwise, the SR that was prepared as part of the subframe-PUCCH transmission is not transmitted on that slot/subslot-PUCCH. The UE shall transmit the HARQ-ACK response associated with the subframe-PUCCH using the slot/subslot-PUCCH (as defined in Clause 7.3). The UE shall apply spatial HARQ-ACK bundling on the HARQ-ACK response associated with the subframe-PUCCH

- in case subslot-PUCCH is used

- in case slot-PUCCH is used if bundling is configured for the cell (see *spatialBundlingPUCCH* in 3GPP TS 36.331 [11]).

For a serving cell, and a UE configured with higher layer parameter *shortTTI*, the UE is not expected to transmit subframe-PUCCH in a given subframe if the UE detects PDCCH/SPDCCH with uplink DCI format 7-0A/7-0B corresponding to a slot/subslot-PUSCH transmission in the same subframe. In this case, the UE shall transmit the HARQ-ACK response associated with the subframe-PUCCH on slot/subslot-PUSCH (as defined in Clause 7.3). The UE shall apply spatial HARQ-ACK bundling on the HARQ-ACK response associated with the subframe-PUCCH

- in case subslot-PUSCH is used

- in case slot-PUSCH is used if bundling is configured for the cell (see *spatialBundlingPUCCH* in 3GPP TS 36.331 [11]).

For a UE configured with more than one serving cell and not capable of simultaneous transmission of different uplink signal durations to different serving cells as indicated by UE capability *simultaneousTx-differentTx-duration*, in case of a collision between

- a slot-PUCCH of first serving cell and a subframe-PUSCH/PUCCH/SRS/PRACH of second serving cell or

- a subslot-PUCCH of first serving cell and a subframe/slot-PUSCH/PUCCH/SRS/PRACH of second serving cell

the uplink transmission(s) of the second serving cell are dropped.

For a UE configured with higher layer parameter *ul-STTI-Length*, and not configured with simultaneous PUSCH and PUCCH transmissions, the UE is not expected to transmit PUCCH and demodulation reference signal for PUSCH in a slot/subslot in which the UE does not transmit PUSCH.

For a serving cell, and a UE configured with higher layer parameter *ul-STTI-Length*, if the UE is configured with simultaneous PUSCH and PUCCH transmission, in case subframe-PUSCH and/or subframe-PUCCH collide(s) with slot/subslot-PUCCH, the UE is not expected to transmit either of subframe-PUSCH or subframe-PUCCH. The UE shall transmit the HARQ-ACK response corresponding to the subframe-PUSCH/PUCCH using the slot/subslot-PUCCH (as defined in Clause 7.3).

For a serving cell, and a UE configured with higher layer parameter *ul-STTI-Length*, if the UE is configured with simultaneous PUSCH and PUCCH transmission, in case subframe-PUSCH and/or subframe-PUCCH collide(s) with slot/subslot-PUSCH and slot/subslot-PUCCH, the UE is not expected to transmit either of subframe-PUSCH or subframe-PUCCH. The UE shall transmit the HARQ-ACK response corresponding to the subframe-PUSCH/PUCCH using the slot/subslot-PUCCH (as defined in Clause 7.3).

For FDD or FDD-TDD and primary cell frame structure 1, with two configured serving cells and PUCCH format 1b with channel selection or for FDD with one or more configured serving cells, and the higher layer parameters *dl-STTI-Length='subslot'* and *ul-STTI-Length='slot'*, and PUCCH format 3 and without PUCCH format 4 configured, or for FDD with two or more configured serving cells and PUCCH format 3 and without PUCCH format 4/5 configured,  where  is the number of configured cells and  is the number of transport blocks or the SPS release PDCCH/EPDCCH/SPDCCH, if any, received in serving cell , and in

- subframe 

- slot 

- any of the subslots given in Table 10.1-1 according to the value of  when the slot-PUCCH is transmitted in subframe *m*.

Table 10.1-1: Set of subslot numbers for  calculation

|  |  |  |
| --- | --- | --- |
|  | Slot number | Subslot numbers |
| 4 |  | {0,1,2} in subframe *m-1* |
|  | {3,4,5} in subframe *m-1* |
| 6 |  | {0} in subframe *m-1*  {4,5} in subframe *m-2* |
|  | {1,2,3} in subframe *m-1* |
| 8 |  | {2,3,4} in subframe *m-2* |
|  | {0,1} in subframe *m-1*  {5} in subframe *m-2* |

For TDD and a UE not configured with the parameter *EIMTA-MainConfigServCell-r12* for any serving cell, if a UE is configured with one serving cell, or the UE is configured with more than one serving cell and the UL/DL configurations of all serving cells are the same, then

- For TDD with two configured serving cells and PUCCH format 1b with channel selection and a subframe *n* with *M = 1*, or for TDD UL/DL configuration 0 and PUCCH format 3, , where is the number of transport blocks or the SPS release PDCCH/EPDCCH/SPDCCH, if any, received in subframe/slot  in serving cell , where , and *M* is the number of elements in *K*.

- For TDD UL/DL configurations 1-6 and PUCCH format 3 and without PUCCH format 4/5 configured, or for TDD with two configured serving cells and PUCCH format 1b with channel selection and *M* = 2,  where  is the  in serving cell ,  is the  in serving cell , and  is the number of HARQ-ACK bits corresponding to the configured DL transmission mode on serving cell . In case spatial HARQ-ACK bundling is applied,  and  is the number of PDCCH/EPDCCH or PDSCH without a corresponding PDCCH/EPDCCH received in subframe  and serving cell, where  and *M* is the number of elements in *K*. In case spatial HARQ-ACK bundling is not applied, is the number of transport blocks received or the SPS release PDCCH/EPDCCH received in subframe  in serving cell , where  and *M* is the number of elements in *K*. =0 if no transport block or SPS release PDCCH/EPDCCH is detected in subframe(s)  in serving cell , where .

- For TDD with two configured serving cells and PUCCH format 1b with channel selection and *M* = 3 or 4,  if UE receives PDSCH or PDCCH/EPDCCH indicating downlink SPS release only on one serving cell within subframes ,where ;otherwise .

For TDD if the UE is configured with more than one serving cell and if at least two serving cells have different UL/DL configurations, 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 2, then

- For PUCCH format 3 without PUCCH format 4/5 configured, or for two configured serving cells and PUCCH format 1b with channel selection and  (defined in Clause 10.1.3.2.1 for TDD and Clause 10.1.3A for FDD-TDD),  where  is the  in serving cell ,  is the  in serving cell , and  is the number of HARQ-ACK bits corresponding to the configured DL transmission mode on serving cell . In case spatial HARQ-ACK bundling is applied,  and  is the number of PDCCH/EPDCCH/SPDCCH or PDSCH without a corresponding PDCCH/EPDCCH/SPDCCH received in subframe/slot/subslot  and serving cell, where  and (defined in Clause 7.3.2.2 for TDD and Clause 7.3.4 for FDD-TDD). In case spatial HARQ-ACK bundling is not applied, is the number of transport blocks received or the SPS release PDCCH/EPDCCH received in subframe/slot/subslot  in serving cell , where  and (defined in Clause 7.3.2.2 for TDD and Clause 7.3.4 for FDD-TDD). =0 if no transport block or SPS release PDCCH/EPDCCH/SPDCCH is detected in subframe(s)  in serving cell , where  and (defined in Clause 7.3.2.2 for TDD and Clause 7.3.4 for FDD-TDD). For a serving cell , set if the DL-reference UL/DL configuration (defined in Clause 10.2) for serving cell  is TDD UL/DL configuration 0,

- For two configured serving cells and PUCCH format 1b with channel selection and *M* = 3 or 4 (defined in Clause 10.1.3.2.1 for TDD and Clause 10.1.3A for FDD-TDD),  if UE receives PDSCH or PDCCH/EPDCCH indicating downlink SPS release only on one serving cell within subframes ,where  and (defined in Clause 7.3.2.2 for TDD and Clause 7.3.4 for FDD-TDD); otherwise .

Throughout the following Clauses, subframes are numbered in monotonically increasing order; if the last subframe of a radio frame is denoted as , the first subframe of the next radio frame is denoted as .

Throughout the following Clauses for a non-BL/CE UE, if the UE is configured with higher layer parameter *shortProcessingTime* and the corresponding PDCCH with CRC scrambled by C-RNTI is in the UE-specific search spacethen for FDD or FDD-TDD primary cell frame structure type 1  is given by *n1PUCCH-AN-shortPT* else if the UE is configured with higher layer parameter *n1PUCCH-AN-r11* then  is given by *n1PUCCH-AN-r11*, else  is given by higher layer parameter *n1PUCCH-AN .*

### 10.1.1 PUCCH format information

Using the PUCCH formats defined in Clause 5.4.1, 5.4.2, 5.4.2A, 5.4.2B, 5.4.2C, 5.4A.2, 5.4A.3, and 5.4A.4 in [3], the following combinations of UCI on PUCCH are supported:

- Format 1a for 1-bit HARQ-ACK or in case of FDD or FDD-TDD primary cell frame structure type 1 for 1-bit HARQ-ACK with positive SR.

- Format 1b for 2-bit HARQ-ACK or for 2-bit HARQ-ACK with positive SR.

- Format 1b for up to 4-bit HARQ-ACK with channel selection when the UE is configured with more than one serving cell or, in the case of TDD, when the UE is configured with a single serving cell.

- Format 1 for positive SR.

- Format 2 for a CSI report when not multiplexed with HARQ-ACK.

- Format 2a for a CSI report multiplexed with 1-bit HARQ-ACK for normal cyclic prefix.

- Format 2b for a CSI report multiplexed with 2-bit HARQ-ACK for normal cyclic prefix.

- Format 2 for a CSI report multiplexed with HARQ-ACK for extended cyclic prefix.

- For subframe-PUCCH, format 3 for up to 10-bit HARQ-ACK for FDD or FDD-TDD primary cell frame structure type 1 and for up to 20-bit HARQ-ACK for TDD and for up to 21 bit HARQ-ACK for FDD-TDD primary cell frame structure type 2.

- For subframe-PUCCH, format 3 for up to 11-bit corresponding to 10-bit HARQ-ACK and 1-bit positive/negative SR for FDD or FDD-TDD and for up to 21-bit corresponding to 20-bit HARQ-ACK and 1-bit positive/negative SR for TDD and for up to 22-bit corresponding to 21-bit HARQ-ACK and 1-bit positive/negative SR for FDD-TDD primary cell frame structure type 2.

- For subframe-PUCCH, format 3 for HARQ-ACK, 1-bit positive/negative SR (if any) and CSI report(s).

- For subframe-PUCCH, format 3 for up to 22 bits of UCI including HARQ-ACK, SR (if any) and periodic CSI report(s) (if any) for UE configured with Format 4 or Format 5 or for UE configured with more than 5 serving cells..

- For slot-PUCCH, Format 3 for up to 11-bits of UCI including HARQ-ACK, SR.

- For subframe-PUCCH, format 4 for more than 22 bits of UCI including HARQ-ACK, SR (if any) and periodic CSI report(s) (if any).

- For slot-PUCCH, Format 4 for more than 11 bits of UCI including HARQ-ACK, SR (if any) for UE configured with slot-PUCCH format 3

- For slot-PUCCH, Format 4 for more than 2 bits of UCI including HARQ-ACK, SR (if any) for UE not configured with slot-PUCCH format 3

- For subslot-PUCCH, Format 4 for more than 3 bits of UCI including HARQ-ACK, SR (if any)

- For subframe-PUCCH, format 5 for more than 22 bits of UCI including HARQ-ACK, SR (if any) and periodic CSI report(s) (if any).

- For subframe-PUCCH, format 4 for more than one CSI report, SR (if any) and HARQ-ACK corresponding to PDSCH transmission only on the primary cell (if any).

- For subframe-PUCCH, format 5 for more than one CSI report, SR (if any) and HARQ-ACK corresponding to PDSCH transmission only on the primary cell (if any).

For slot-PUCCH only PUCCH formats 1/1a/1b, 3, 4 are supported. For subslot-PUCCH only PUCCH formats 1/1a/1b, and 4 are supported.

For a UE configured with PUCCH format 3, not configured with PUCCH format 4/5, and for HARQ-ACK transmission on PUSCH or using PUCCH format 3, or for a UE configured with two serving cells and PUCCH format 1b with channel selection and HARQ-ACK transmission on PUSCH, or for a non BL/CE UE configured with one serving cell and PUCCH format 1b with channel selection according to Tables 10.1.3-5, 10.1.3-6, 10.1.3-7 and HARQ-ACK transmission on PUSCH or for a UE configured with PUCCH format 4/5 and HARQ-ACK transmission on PUSCH or using PUCCH format 3/4/5:

- for subframe-PDSCH, if the configured downlink transmission mode for a serving cell supports up to 2 transport blocks and only one transport block is received in a subframe, the UE shall generate a NACK for the other transport block if spatial HARQ-ACK bundling is not applied.

- if neither PDSCH nor PDCCH/EPDCCH/SPDCCH indicating downlink SPS release is detected in a subframe/slot/subslot for a serving cell, the UE shall generate two NACKs when the configured downlink transmission mode supports up to 2 transport blocks and the UE shall generate a single NACK when the configured downlink transmission mode supports a single transport block.

For a UE configured with PUCCH format 4/5 and with a transmission mode supporting two transport blocks in at least one serving cell, the HARQ-ACK response for subframe-PDSCH, and for a serving cell configured with a transmission mode supporting one transport block is associated with the first codeword. The UE shall generate a NACK for the second codeword if spatial bundling is not applied, and shall generate the same HARQ-ACK response for the second codeword as that for the first codeword if spatial bundling is applied.

For a BL/CE UE configured with PUCCH format 1b with channel selection according to Tables 10.1.3-5, 10.1.3-6, 10.1.3-7, if neither PDSCH nor MPDCCH indicating downlink SPS release is detected in a subframe for a serving cell, the UE shall generate a single NACK.

The scrambling initialization of PUCCH format 2, 2a, 2b, 3, 4 and 5 is by C-RNTI.

For a non-BL/CE UE that is configured with a single serving cell and is not configured with PUCCH format 3, in case of collision between a periodic CSI report and an HARQ-ACK in a same subframe without PUSCH, the periodic CSI report is multiplexed with HARQ-ACK on PUCCH if the parameter *simultaneousAckNackAndCQI* provided by higher layers is set *TRUE*, otherwise the CSI is dropped.

A UE that is configured with PUCCH format 4/5 is not expected to be configured with different values for *simultaneousAckNackAndCQI-Format3* and *simultaneousAckNackAndCQI-Format4-Format5*.

For a BL/CE UE,

- if both *pucch-NumRepetitionCE-format1* and *pucch-NumRepetitionCE-format2* equal 1, in case of collision among two or more of a periodic CSI report, an HARQ-ACK and a SR in a same subframe without PUSCH, the UE behavior follows that of a non-BL/CE UE.

- if at least one of *pucch-NumRepetitionCE-format1* and *pucch-NumRepetitionCE-format2* is larger than 1, in case of collision among two or more of a periodic CSI report, an HARQ-ACK, and a SR in a same subframe without PUSCH, the highest priority UCI is transmitted, where the priority of HARQ-ACK is higher than SR and the priority of SR is higher than periodic CSI report.

For TDD and for a UE that is configured with a single serving cell and with PUCCH format 3, in case of collision between a periodic CSI report and an HARQ-ACK in a same subframe without PUSCH, if the parameter *simultaneousAckNackAndCQI* provided by higher layers is set *TRUE* or if the parameter *simultaneousAckNackAndCQI-Format3-r11* provided by higher layers is set *TRUE*, the periodic CSI report is multiplexed with HARQ-ACK or dropped as described in Clause 7.3, otherwise the CSI is dropped.

For FDD or for FDD-TDD and primary cell frame structure type 1 and for a UE that is configured with more than one serving cell and is not configured with PUCCH format 4/5, in case of collision between a periodic CSI report and an HARQ-ACK in a same subframe without PUSCH,

- if the parameter simultaneousAckNackAndCQI provided by higher layers is set TRUE and if the HARQ-ACK corresponds to a PDSCH transmission or PDCCH/EPDCCH indicating downlink SPS release only on the primary cell,

then the periodic CSI report is multiplexed with HARQ-ACK on PUCCH using PUCCH format 2/2a/2b

- else if the UE is configured with PUCCH format 3 and if the parameter *simultaneousAckNackAndCQI-Format3-r11* provided by higher layers is set *TRUE*, and if PUCCH resource is determined according to Clause 10.1.2.2.2, and

- if the total number of bits in the subframe corresponding to HARQ-ACKs, SR (if any), and the CSI is not larger than 22 or

- if the total number of bits in the subframe corresponding to spatially bundled HARQ-ACKs, SR (if any), and the CSI is not larger than 22

then the periodic CSI report is multiplexed with HARQ-ACK on PUCCH using the determined PUCCH format 3 resource according to [4]

- otherwise,

CSI is dropped.

For FDD or for FDD-TDD and primary cell frame structure type 1, for a UE configured with PUCCH format 4 or PUCCH format 5, and if the UE has HARQ-ACK/SR and periodic CSI reports to transmit in a subframe,

- if a PUCCH format 3 is determined to transmit the HARQ-ACK/SR according to Clause 10.1.2.2.3 or 10.1.2.2.4, the UE shall use the determined PUCCH format 3 for transmission of the HARQ-ACK/SR and periodic CSI report(s) if the parameter *simultaneousAckNackAndCQI-Format3-r11* provided by higher layers is set *TRUE*; otherwise, the UE shall drop the periodic CSI report(s) and transmit only HARQ-ACK/SR;

- if a PUCCH format 4 is determined to transmit the HARQ-ACK/SR according to Clause 10.1.2.2.3 or a PUCCH format 5 is determined to transmit the HARQ-ACK/SR according to 10.1.2.2.4, the UE shall used the determined PUCCH format 4 or PUCCH format 5 for transmission of the HARQ-ACK/SR and periodic CSI report(s) if the parameter *simultaneousAckNackAndCQI-Format4-Format5-r13* provided by higher layers is set *TRUE*; otherwise, the UE shall drop the periodic CSI report(s) and transmit only HARQ-ACK/SR;

- if there is no PUCCH format 3 or 4 determined to transmit the HARQ-ACK/SR according to Clause 10.1.2.2.3 and there is no PUCCH format 3 or 5 determined to transmit the HARQ-ACK/SR according to Clause 10.1.2.2.4 and there are more than one periodic CSI report(s) in the subframe,

- if the parameter *simultaneousAckNackAndCQI-Format4-Format5-r13* provided by higher layers is set *TRUE* and if the UE is configured with a single PUCCH format 4 resource  according to higher layer parameter *format4-MultiCSI-resourceConfiguration*, the PUCCH format 4 resource  is used for transmission of the HARQ-ACK/SR and periodic CSI report(s);

- if the parameter *simultaneousAckNackAndCQI-Format4-Format5-r13* provided by higher layers is set *TRUE* and if the UE is configured with a PUCCH format 5 resource according to higher layer parameter *format5-MultiCSI-resourceConfiguration*, the PUCCH format 5 resource is used for transmission of the HARQ-ACK/SR and periodic CSI report(s);

- if the parameter *simultaneousAckNackAndCQI-Format4-Format5-r13* provided by higher layers is set *TRUE* and if the UE is configured with two PUCCH format 4 resources  and according to higher layer parameter *format4-MultiCSI-resourceConfiguration*, if , the PUCCH format 4 resource with the smaller  between  and  is used for transmission of the HARQ-ACK/SR and periodic CSI report(s); otherwise, the PUCCH format 4 resource with the larger  between  and  is used for transmission of the HARQ-ACK/SR and periodic CSI report(s), where

-  is the total number of HARQ-ACK bits in the subframe;

- if there no scheduling request bit in the subframe and  otherwise

-  is the total number of CSI report bits in the subframe;

-  is the number of CRC bits;

- , , is the number of PRBs for  and  respectively, according to higher layer parameter *numberOfPRB-format4-r13* according to Table 10.1.1-2;

-  if shortened PUCCH format 4 is used in the subframe and  otherwise; and

-  is the code rate given by higher layer parameter *maximumPayloadCoderate-r13* according to Table 10.1.1-1*;*

- otherwise, the UE shall drop the periodic CSI report(s) and transmit only HARQ-ACK/SR;

- if there is no PUCCH format 3 or 4 determined to transmit the HARQ-ACK/SR according to Clause 10.1.2.2.3 and there is no PUCCH format 3 or 5 determined to transmit the HARQ-ACK/SR according to Clause 10.1.2.2.4 and there are only one periodic CSI report in the subframe,

- if there is no positive SR and the parameter *simultaneousAckNackAndCQI* provided by higher layers is set *TRUE* and if the HARQ-ACK corresponds to a PDSCH transmission or PDCCH/EPDCCH indicating downlink SPS release only on the primary cell, then the periodic CSI report is multiplexed with HARQ-ACK on PUCCH using PUCCH format 2/2a/2b

- else, the UE shall drop the CSI and transmit the HARQ-ACK according to Clause 10.1.2.2.3 or 10.1.2.2.4 when UE shall transmit HARQ-ACK only or UE shall drop the CSI and transmit the HARQ-ACK and SR according to the procedure for FDD with PUCCH format 1a/1b when there is positive SR.

- If a UE transmits HARQ-ACK/SR and periodic CSI report(s) using either a PUCCH format 4  or PUCCH format 5 in a subframe

- if , the UE shall transmit the HARQ-ACK/SR and periodic CSI bits using the PUCCH format 4  or the PUCCH format 5  ;

- if , the UE shall select  CSI report(s) for transmission together with HARQ-ACK/SR in ascending order of , where ,  and are determined according to Clause 7.2.2; the value of  satisfies  and , and  is the number of CSI report bits for the *n*th CSI report in ascending order of .

For a UE configured with higher layer parameter *shortTTI,* if the UE has subslot-SR and subframe-PUSCH/PUCCH including more than 2 HARQ-ACK bits either on the same serving cell or on different serving cells in a subframe when the UE is not capable of simultaneous transmission of different uplink signal durations on different serving cells as indicated by the UE capability *simultaneousTx-differentTx-duration*, and if the UE does not have HARQ-ACK bits corresponding to any subslot-PDSCH in the subslot in which the subslot-SR to be transmitted:

- if the UE is configured with a single subslot-PUCCH format 4 resource according to the higher layer parameter *format4-MultiResource-subslotConfiguration,* the UE shall multiplex HARQ-ACK and SR bits on *.*

- if the UE is configured with two subslot-PUCCH format 4 resources and according to the higher layer parameter *format4-MultiResource-subslotConfiguration, if*  , the subslot-PUCCH format 4 resource with the smaller  between  and  is used for transmission of the HARQ-ACK/SR; otherwise, the subslot-PUCCH format 4 resource with the larger  between  and  is used for transmission of the HARQ-ACK/SR, where

-  is the total number of HARQ-ACK bits on the subframe-PUSCH/PUCCH;

- 

-  is the number of CRC bits;

- , , is the number of PRBs for  and  respectively, according to higher layer parameter *n4numberOfPRBSubslot* according to Table 10.1.1-2;

-  is the code rate given by higher layer parameter n4*maxCoderateSubsloPUCCHt-r15* according to Table 10.1.1-1*;*

For a UE configured with higher layer parameter *shortTTI,* if the UE has slot-SR and subframe-PUSCH/PUCCH including more than 2 HARQ-ACK bits either on the same serving cell or on different serving cells when the UE is not capable of simultaneous transmission of different uplink signal durations on different serving cells as indicated by the UE capability *simultaneousTx-differentTx-duration*, and if the UE does not have HARQ-ACK bits corresponding to any subslot/slot-PDSCH in the slot in which the slot-SR to be transmitted:

- if the UE is either not configured with aslot-PUCCH format 4 according to the higher layer parameter *format4-MultiResource-slotConfiguration,* or the number of HARQ-ACK and SR bits is smaller than or equal to 11 bits, the UE shall multiplex HARQ-ACK and SR bits on slot-PUCCH format 3 resource .

- if the UE is configured with a single PUCCH format 4 resource according to the higher layer parameter *format4-MultiResource-slotConfiguration,* and if either the UE is not configured with a slot-PUCCH resource  or the number of HARQ-ACK and SR bits is larger than 11 bits, the UE shall multiplex HARQ-ACK and SR bits on .

- if the UE is not configured with a slot-PUCCH resource  or if the number of HARQ-ACK and SR bits is larger than 11 bits, and if the UE is configured with two slot-PUCCH format 4 resources  and  according to the higher-layer parameter *format4-MultiResource-slotConfiguration, if*  , the slot-PUCCH format 4 resource with the smaller  between  and  is used for transmission of the HARQ-ACK/SR; otherwise, the slot-PUCCH format 4 resource with the larger  between  and  is used for transmission of the HARQ-ACK/SR, where

-  is the total number of HARQ-ACK bits on the subframe-PUSCH/PUCCH;

- 

-  is the number of CRC bits;

- , , is the number of PRBs for  and  respectively, according to higher layer parameter *n4numberOfPRB* according to Table 10.1.1-2;

-  if shortened slot-PUCCH format 4 is used and  otherwise; and

-  is the code rate given by higher layer parameter n4*maxCoderateSlotPUCCH-r15* according to Table 10.1.1-1*;*

For TDD or for FDD-TDD and primary cell frame structure type 2 and for a UE that is configured with more than one serving cell, in case of collision between a periodic CSI report and an HARQ-ACK in a same subframe without PUSCH, if the parameter *simultaneousAckNackAndCQI* provided by higher layers is set *TRUE* orif the parameter *simultaneousAckNackAndCQI-Format3-r11* provided by higher layers is set *TRUE* orif the parameter *simultaneousAckNackAndCQI-Format4-Format5-r13* provided by higher layers is set *TRUE*, the periodic CSI report is multiplexed with HARQ-ACK or dropped as described in Clause 7.3, otherwise the CSI is dropped.

In case of collision between a periodic CSI report and a HARQ-ACK in a same subframe with PUSCH, the periodic CSI is multiplexed with the HARQ-ACK in the PUSCH transmission in that subframe if the UE is not configured by higher layers for simultaneous PUCCH and PUSCH transmissions or if the UE is provided by higher layers a parameter *simultaneousAckNackAndCQI-Format4-Format5-r13* that is set *FALSE*. If the UE is configured by higher layers for simultaneous PUCCH and PUSCH transmissions, and if the UE does not determine PUCCH format 4/5 for periodic CSI and HARQ-ACK transmission or if the UE is provided by higher layers a parameter *simultaneousAckNackAndCQI-Format4-Format5-r13* that is set *FALSE*, the HARQ-ACK is transmitted in the PUCCH and the periodic CSI is transmitted in the PUSCH (other than a LAA SCell). If the UE is configured by higher layers for simultaneous PUCCH and PUSCH transmissions and if the UE determines PUCCH format 4/5 for periodic CSI and HARQ-ACK transmission and if the UE is provided by higher layers a parameter *simultaneousAckNackAndCQI-Format4-Format5-r13* that is set *TRUE*, the periodic CSI and HARQ-ACK is transmitted in PUCCH format 4/5.

In case of collision between a periodic CSI report and a HARQ-ACK in a same subframe with PUSCH and if an aperiodic CSI report is not triggered for the same subframe, and if a UE is transmitting PUSCH only on LAA SCell(s), the HARQ-ACK and periodic CSI transmission follows the procedure for the case of collision between a periodic CSI report and a HARQ-ACK in the same subframe without PUSCH.

For a BL/CE UE, in case of collision between a UCI and a PUSCH transmission in a same subframe, if the number of PUCCH repetitions defined for the UCI in [3] is larger than 1 or if the indicated PUSCH repetition number in DCI format 6-0A/6-0B is larger than 1 or if the PUSCH resource assignment is using uplink resource allocation type 5, the PUSCH transmission is dropped in that subframe.

For a BL/CE UE in half-duplex FDD operation, in case of collision between a PUCCH format 2 transmission including half-duplex guard subframe and a PDSCH reception with repetitions, the PUCCH format 2 transmission is dropped if:

- the PUCCH is transmitted starting in subframe *n*, and the MPDCCH scheduling the PDSCH ends in subframe *k*, with *n-k*≥*4*, or

- the PDSCH is semi-statically scheduled.

For a BL/CE UE, in case of collision between at least one physical resource block to be used for transmission of UCI on PUCCH (defined in [3]) and physical resource blocks corresponding to configured PRACH resources for BL/CE UEs or non-BL/CE UEs (defined in [3]) in a same subframe, the PUCCH is dropped in that subframe.

If a UE is configured with higher layer parameter *shortTTI*, the UE is not expected to transmit slot-PUCCH in UpPTS of the special subframe in frame structure type 2.

If each of the serving cells configured for the UE has frame structure type 1, UE procedures for HARQ-ACK feedback are given in Clause 10.1.2.

If each of the serving cells configured for the UE has frame structure type 2, UE procedures for HARQ-ACK feedback are given in Clause 10.1.3.

If the UE is configured for more than one serving cell, and if the frame structure type of any two configured serving cells is different, and if the primary cell is frame structure type 1, UE procedure for HARQ-ACK feedback is given in Clause 10.1.2A.

If the UE is configured for more than one serving cell, and if the frame structure type of any two configured serving cells is different, and if the primary cell is frame structure type 2, UE procedure for HARQ-ACK feedback is given in Clause 10.1.3A.

Table 10.1.1-1: code rate  corresponding to higher layer parameter *maximumPayloadCoderate-r13 or n4maxCoderateSlotPUCCH-r15 or n4maxCoderateSubslotPUCCH-r15*

|  |  |
| --- | --- |
| Value of *maximumPayloadCoderate-r13* or *n4maxCoderateSlotPUCCH-r15* or *n4maxCoderateSubslotPUCCH-r15* | Code rate |
|
| 0 | 0.08 |
| 1 | 0.15 |
| 2 | 0.25 |
| 3 | 0.35 |
| 4 | 0.45 |
| 5 | 0.60 |
| 6 | 0.80 |
| 7 | Reserved |

Table 10.1.1-2: Number of PRBs for PUCCCH format 4  corresponding to higher layer parameter *numberOfPRB-format4-r13 or n4numberOfPRBSubslot* or *n4numberOfPRB*

|  |  |
| --- | --- |
| **Value of *numberOfPRB-format4-r13 or n4numberOfPRBSubslot* *or*** ***n4numberOfPRB*** |  |
|
| 0 | 1 |
| 1 | 2 |
| 2 | 3 |
| 3 | 4 |
| 4 | 5 |
| 5 | 6 |
| 6 | 8 |
| 7 | Reserved |

If a UE is configured with more than 5 serving cells and is configured with PUCCH format 3 and not configured with PUCCH format 4/5:

- The UE can assume that the total number of bits in a given

- subframe corresponding to HARQ-ACK (if any), SR (if any), and periodic CSI (if any) is not larger than 22.

- slot corresponding to HARQ-ACK (if any), SR (if any) is not larger than 11.

- For calculating the HARQ-ACK bits to be transmitted, the UE shall follow the procedure in clauses 10.1.2.2.3, 10.1.2A, 10.1.3.2.3, 10.1.3A by assuming that PUCCH format 4 is configured.

### 10.1.2 FDD HARQ-ACK feedback procedures

For FDD and for a UE not configured with PUCCH format 4/5 and transmitting HARQ-ACK using PUCCH format 1b with channel selection or PUCCH format 3, the UE shall determine the number of HARQ-ACK bits, , based on the number of configured serving cells and the downlink transmission modes configured for each serving cell. The UE shall use two HARQ-ACK bits for a serving cell configured with a downlink transmission mode that support up to two transport blocks; and one HARQ-ACK bit otherwise.

If a UE is configured with higher layer parameters *shortTTI,* codebooksizeDetermination= cc, and codebooksizeDeterminationsSTTI= cc for a PUCCH group and transmitting slot/subslot-PUCCH, the UE shall determine the number of HARQ-ACK bits, , based on the number of configured serving cells for subframe-PDSCH, number of configured serving cells for slot/subslot-PDSCH and the downlink transmission modes configured for each serving cell.

A UE that supports aggregating at most 2 serving cells with frame structure type 1 shall use PUCCH format 1b with channel selection for transmission of HARQ-ACK corresponding to subframe-PDSCH when configured with more than one serving cell with frame structure type 1.

A UE that supports aggregating more than 2 serving cells with frame structure type 1 is configured by higher layers to use either PUCCH format 1b with channel selection or PUCCH format 3/4/5 for transmission of HARQ-ACK corresponding to subframe-PDSCH when configured with more than one serving cell with frame structure type 1.

The FDD HARQ-ACK feedback procedure for one configured serving cell is given in Clause 10.1.2.1 and procedures for more than one configured serving cell are given in Clause 10.1.2.2.

#### 10.1.2.1 FDD HARQ-ACK procedure for one configured serving cell

HARQ-ACK transmission on two antenna ports  is supported for PUCCH format 1a/1b.

For FDD and one configured serving cell, the UE shall use PUCCH resource  for transmission of HARQ-ACK in subframe  for  mapped to antenna port *p* for PUCCH format 1a/1b [3], where

* for a PDSCH transmission indicated by the detection of a corresponding PDCCH in subframe , or for a PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe  , the UE shall use  for antenna port , where  is the number of the first CCE (i.e. lowest CCE index used to construct the PDCCH) used for transmission of the corresponding DCI assignment and  is configured by higher layers. For two antenna port transmission the PUCCH resource for antenna port  is given by .
* for a non-BL/CE UE, and for a PDSCH transmission on the primary cell where there is not a corresponding PDCCH/EPDCCH detected in subframe , the value of  is determined according to higher layer configuration and Table 9.2-2. For a UE configured for two antenna port transmission, a PUCCH resource value in Table 9.2-2 maps to two PUCCH resources with the first PUCCH resource  for antenna port  and the second PUCCH resource  for antenna port , otherwise, the PUCCH resource value maps to a single PUCCH resource  for antenna port .
* for a PDSCH transmission indicated by the detection of a corresponding EPDCCH in subframe  , or for an EPDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe  , the UE shall use

- if EPDCCH-PRB-set is configured for distributed transmission  


- if EPDCCH-PRB-set is configured for localized transmission  


for antenna port , where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.2.1-1,  for EPDCCH-PRB-set is configured by the higher layer parameter *pucch-ResourceStartOffset-r11 ,* for EPDCCH-PRB-set is given in Clause 6.8A.1 in [3], is determined from the antenna port used for localized EPDCCH transmission which is described in Clause 6.8A.5 in [3]. For two antenna port transmission the PUCCH resource for antenna port  is given by

- if EPDCCH-PRB-set is configured for distributed transmission  


- if EPDCCH-PRB-set is configured for localized transmission  


* for a BL/CE UE, and for a PDSCH on the primary cell where there is not a corresponding MPDCCH detected and subframe  is the last subframe in which the PDSCH is transmitted, the value of  is determined according to higher layer configuration and Table 9.2-2.
* for a PDSCH transmission indicated by the detection of a corresponding MPDCCH, or for an MPDCCH indicating downlink SPS release (defined in Clause 9.2) where subframe  is the last subframe in which the PDSCH is transmitted, or for HD-FDD HARQ-ACK bundling, subframe  is the last subframe in which the PDSCH is detected, the UE shall use

- if MPDCCH-PRB-set is configured for distributed transmission  


- if MPDCCH-PRB-set is configured for localized transmission  


for antenna port , where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the MPDCCH) used for transmission of the corresponding DCI assignment in MPDCCH-PRB-set , or for HD-FDD HARQ-ACK bundling  is the number of the first ECCE (i.e. lowest ECCE index used to construct the MPDCCH) in the last detected MPDCCH used for transmission of the corresponding DCI assignment in MPDCCH-PRB-set ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding MPDCCH as given in Table 10.1.2.1-1,  for MPDCCH-PRB-set  is configured

- by the higher layer parameter *n1PUCCH-AN-r13*, if configured; otherwise:

- by the higher layer parameter *n1PUCCH-AN-InfoList-r13* for the corresponding CE level*,*

for MPDCCH-PRB-set  is given in Clause 6.8A.1 in [3] where the same  value is used for each subframe containing a repeat of a MPDCCH transmission,  is determined from the antenna port used for localized MPDCCH transmission which is described in Clause 6.8A.5 in [3]. When an MPDCCH-PRB-set is 2+4, following procedures is applied.

- if the last detected MPDCCH is located within 2 PRB set, is obtained by above procedure.

- if the last detected MPDCCH is located within 4 PRB set, is the sum between and the value obtained by above procedure.

- if the last detected MPDCCH is MPDCCH format 5, is obtained by the above procedure with  = 0.

Table 10.1.2.1-1: Mapping of ACK/NACK Resource offset Field   
in DCI format 1A/1B/1D/1/2A/2/2B/2C/2D/6-1A/6-1B to values

|  |  |
| --- | --- |
| ACK/NACK Resource offset field  in DCI format 1A/1B/1D/1/2A/2/2B/2C/2D |  |
| 0 | 0 |
| 1 | -1 |
| 2 | -2 |
| 3 | 2 |

For slot-PUCCH, and for transmission of up to 2 HARQ-ACK bits in slot , when at least one HARQ-ACK bit is sent in response to a PDSCH transmission indicated by the detection of a corresponding PDCCH/SPDCCH with DCI format 7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G or a semi-persistently scheduled slot-PDSCH transmission or for a PDCCH/SPDCCH indicating downlink SPS release in

- slot  or

- when scheduling request is sent in slot on a resource configured by higher layer parameter *sr-slotSPUCCH-IndexFH or sr-slotSPUCCH-IndexNoFH*,

the UE shall use PUCCH resource  for transmission of HARQ-ACK in slot  for  mapped to antenna port *p* for slot-PUCCH transmission using format 1a/1b [3], where the value of  is determined according to higher layer configuration and Table 10.1.2.1-2. For a UE configured for two antenna port transmission for PUCCH format 1a/1b, a PUCCH resource value in Table 10.1.2.1-2 maps to two PUCCH resources with the first PUCCH resource  for antenna port  and the second PUCCH resource  for antenna port , otherwise, the PUCCH resource value maps to a single PUCCH resource  for antenna port .

Table 10.1.2.1-2: PUCCH Resource Value for HARQ-ACK Resource for slot-PUCCH

|  |  |
| --- | --- |
| Value of 'SPUCCH resource indication' field  as defined in clause 5.3.3.1.17 of [4] | or |
| '00' | The 1st PUCCH resource value configured by the higher layers |
| '01' | The 2nd PUCCH resource value configured by the higher layers |
| '10' | The 3rd PUCCH resource value configured by the higher layers |
| '11' | The 4th PUCCH resource value configured by the higher layers |
| NOTE: are respectively determined from the first and second PUCCH resource lists configured by *n1SlotSPUCCH-hoppingAN-List* in [11] for slot-PUCCH when hopping is enabled, and by *n1SlotSPUCCH-nohoppingAN-List* in [11] for slot-PUCCH when hopping is disabled. | |

For subslot-PUCCH, and for transmission of up to 2 HARQ-ACK bits, in subslot , when at least one HARQ-ACK bit is sent in response to a PDSCH transmission indicated by the detection of a corresponding PDCCH/SPDCCH with DCI format 7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G in subslot  or a semi-persistently scheduled subslot-PDSCH transmission in subslot  or for a PDCCH/SPDCCH indicating downlink SPS release in subslot  or when scheduling request is sent in subslot on a resource configured by higher layer parameter *sr-subslotSPUCCH-Resource,* the UE shall use PUCCH resource  for transmission of HARQ-ACK in subslot  for  mapped to antenna port *p* for subslot-PUCCH transmission using format 1a/1b [3], where

- for a PDSCH transmission indicated by the detection of a corresponding PDCCH/SPDCCH with DCI format 7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G in subslot or a semi-persistently scheduled subslot-PDSCH transmission in subslotor for a PDCCH/SPDCCH indicating downlink SPS release in subslot , PUCCH resource groupisdetermined by higher layer configuration and Table 10.1.2.1-3, and  is determined according to higher layer configuration and Table 10.1.2.1-4 for PUCCH format 1a, and according to higher layer configuration and Table 10.1.2.1-5 for PUCCH format 1b.

Table 10.1.2.1-3: PUCCH Resource Group Value for HARQ-ACK Resource for PUCCH

|  |  |
| --- | --- |
| Value of 'SPUCCH' resource indication field' | PUCCH resource group |
| '00' | The 1st PUCCH resource group value configured by the higher layers |
| '01' | The 2nd PUCCH resource group value configured by the higher layers |
| '10' | The 3rd PUCCH resource group value configured by the higher layers |
| '11' | The 4th PUCCH resource group value configured by the higher layers |

Table 10.1.2.1-4: Transmission of Format 1a HARQ-ACK for subslot-PUCCH

|  |  |
| --- | --- |
| HARQ-ACK |  |
| NACK | The 1st PUCCH resource value configured by the higher layers for the indicated PUCCH resource group |
| ACK | The 2nd PUCCH resource value configured by the higher layers for the indicated PUCCH resource group |

Table 10.1.2.1-5: Transmission of Format 1b HARQ-ACK for subslot-PUCCH

|  |  |  |
| --- | --- | --- |
| HARQ-ACK(0) | HARQ-ACK(1) |  |
| NACK | NACK | The 1st PUCCH resource value configured by the higher layers for the indicated PUCCH resource group |
| ACK | NACK | The 2nd PUCCH resource value configured by the higher layers for the indicated PUCCH resource group |
| NACK | ACK | The 3rd PUCCH resource value configured by the higher layers for the indicated PUCCH resource group |
| ACK | ACK | The 4th PUCCH resource value configured by the higher layers for the indicated PUCCH resource group |

#### 10.1.2.2 FDD HARQ-ACK procedures for more than one configured serving cell

The FDD HARQ-ACK feedback procedures for more than one configured serving cell are either based on a PUCCH format 1b with channel selection HARQ-ACK procedure as described in Clause 10.1.2.2.1 or a PUCCH format 3 HARQ-ACK procedure as described in Clause 10.1.2.2.2 or a PUCCH format 4 HARQ-ACK procedure as described in Clause 10.1.2.2.3 or a PUCCH format 5 HARQ-ACK procedure as described in Clause 10.1.2.2.4.

HARQ-ACK transmission on two antenna ports  is supported for PUCCH format 3.

HARQ-ACK transmission on two antenna ports  is supported for PUCCH format 1b with channel selection and FDD with two configured serving cells.

##### 10.1.2.2.1 PUCCH format 1b with channel selection HARQ-ACK procedure

For two configured serving cells and PUCCH format 1b with channel selection, the UE shall transmit  on PUCCH resource  for mapped to antenna port *p* using PUCCH format 1b where

-  for antenna port  where  is selected from  PUCCH resources, where  and, according to Table 10.1.2.2.1-3, Table 10.1.2.2.1-4, Table 10.1.2.2.1-5 in subframe . HARQ-ACK(*j*) denotes the ACK/NACK/DTX response for a transport block or SPS release PDCCH/EPDCCH associated with serving cell , where the transport block and serving cell for HARQ-ACK(*j*) and  PUCCH resources are given by Table 10.1.2.2.1-1.

-  for antenna port, where  is selected from  PUCCH resources, configured by higher layers where  and, according to Table 10.1.2.2.1-3, Table 10.1.2.2.1-4, Table 10.1.2.2.1-5 by replacing with and replacing with  in subframe , when the UE is configured with two antenna port transmission for PUCCH format 1b with channel selection.

A UE configured with a transmission mode that supports up to two transport blocks on serving cell, , shall use the same HARQ-ACK response for both the transport blocks in response to a PDSCH transmission with a single transport block or a PDCCH/EPDCCH indicating downlink SPS release associated with the serving cell .

Table 10.1.2.2.1-1: Mapping of Transport Block and Serving Cell to HARQ-ACK(*j*)  
 for PUCCH format 1b HARQ-ACK channel selection

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| A | *HARQ-ACK(j)* | | | |
| HARQ-ACK(0) | HARQ-ACK(1) | HARQ-ACK(2) | HARQ-ACK(3) |
| 2 | TB1 Primary cell | TB1 Secondary cell | NA | NA |
| 3 | TB1 Serving cell1 | TB2 Serving cell1 | TB1 Serving cell2 | NA |
| 4 | TB1 Primary cell | TB2 Primary cell | TB1 Secondary cell | TB2 Secondary cell |

The UE shall determine the  PUCCH resources,  associated with HARQ-ACK(*j*) where  in Table 10.1.2.2.1-1, according to

* for a PDSCH transmission indicated by the detection of a corresponding PDCCH in subframe  on the primary cell or in subframe *n-3* if the UE is configured with higher layer parameter *shortProcessingTime* and the corresponding PDCCH with CRC scrambled by C-RNTI is in the UE-specific search space on the primary cell, or for a PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe  on the primary cell, the PUCCH resource is , and for transmission mode that supports up to two transport blocks, the PUCCH resource  is given by  where  is the number of the first CCE used for transmission of the corresponding PDCCH and  is configured by higher layers.
* for a PDSCH transmission on the primary cell where there is not a corresponding PDCCH/EPDCCH detected in subframe , the value of  is determined according to higher layer configuration and Table 9.2-2. For transmission mode that supports up to two transport blocks, the PUCCH resource  is given by 
* for a PDSCH transmission indicated by the detection of a corresponding PDCCH/EPDCCH in subframe  on the secondary cell, the value of , and the value of  for the transmission mode that supports up to two transport blocks is determined according to higher layer configuration and Table 10.1.2.2.1-2. The TPC field in the DCI format of the corresponding PDCCH/EPDCCH shall be used to determine the PUCCH resource values from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.1-2. For a UE configured for a transmission mode that supports up to two transport blocks a PUCCH resource value in Table 10.1.2.2.1-2 maps to two PUCCH resources , otherwise, the PUCCH resource value maps to a single PUCCH resource .
* for a PDSCH transmission indicated by the detection of a corresponding EPDCCH in subframe  on the primary cell, or for an EPDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe  on the primary cell, the PUCCH resource is given by

- if EPDCCH-PRB-set is configured for distributed transmission



- if EPDCCH-PRB-set is configured for localized transmission



where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.2.1-1,  for EPDCCH-PRB-set is configured by the higher layer parameter *pucch-ResourceStartOffset-r11 ,* for EPDCCH-PRB-set is given in Clause 6.8A.1 in [3], is determined from the antenna port used for localized EPDCCH transmission which is described in Clause 6.8A.5 in [3].

For transmission mode that supports up to two transport blocks, the PUCCH resource  is given by

- if EPDCCH-PRB-set is configured for distributed transmission



- if EPDCCH-PRB-set is configured for localized transmission



Table 10.1.2.2.1-2: PUCCH Resource Value for HARQ-ACK Resource for PUCCH

|  |  |
| --- | --- |
| Value of 'TPC command  for PUCCH' | or |
| '00' | The 1st PUCCH resource value configured by the higher layers |
| '01' | The 2nd PUCCH resource value configured by the higher layers |
| '10' | The 3rd PUCCH resource value configured by the higher layers |
| '11' | The 4th PUCCH resource value configured by the higher layers |
| NOTE:  are determined from the first and second PUCCH  resource lists configured by *n1PUCCH-AN-CS-List-r10* in [11], respectively. | |

Table 10.1.2.2.1-3: Transmission of Format 1b HARQ-ACK channel selection for 

|  |  |  |  |
| --- | --- | --- | --- |
| HARQ-ACK(0) | HARQ-ACK(1) |  |  |
| ACK | ACK |  | 1,1 |
| ACK | NACK/DTX |  | 1,1 |
| NACK/DTX | ACK |  | 0,0 |
| NACK | NACK/DTX |  | 0,0 |
| DTX | NACK/DTX | No Transmission | |

Table 10.1.2.2.1-4: Transmission of Format 1b HARQ-ACK channel selection for 

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| HARQ-ACK(0) | HARQ-ACK(1) | HARQ-ACK(2) |  |  |
| ACK | ACK | ACK |  | 1,1 |
| ACK | NACK/DTX | ACK |  | 1,0 |
| NACK/DTX | ACK | ACK |  | 0,1 |
| NACK/DTX | NACK/DTX | ACK |  | 1,1 |
| ACK | ACK | NACK/DTX |  | 1,1 |
| ACK | NACK/DTX | NACK/DTX |  | 1,0 |
| NACK/DTX | ACK | NACK/DTX |  | 0,1 |
| NACK/DTX | NACK/DTX | NACK |  | 0,0 |
| NACK | NACK/DTX | DTX |  | 0,0 |
| NACK/DTX | NACK | DTX |  | 0,0 |
| DTX | DTX | DTX | No Transmission | |

Table 10.1.2.2.1-5: Transmission of Format 1b HARQ-ACK channel selection for 

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HARQ-ACK(0) | HARQ-ACK(1) | HARQ-ACK(2) | HARQ-ACK(3) |  |  |
| ACK | ACK | ACK | ACK |  | 1,1 |
| ACK | NACK/DTX | ACK | ACK |  | 0,1 |
| NACK/DTX | ACK | ACK | ACK |  | 0,1 |
| NACK/DTX | NACK/DTX | ACK | ACK |  | 1,1 |
| ACK | ACK | ACK | NACK/DTX |  | 1,0 |
| ACK | NACK/DTX | ACK | NACK/DTX |  | 0,0 |
| NACK/DTX | ACK | ACK | NACK/DTX |  | 0,0 |
| NACK/DTX | NACK/DTX | ACK | NACK/DTX |  | 1,0 |
| ACK | ACK | NACK/DTX | ACK |  | 1,1 |
| ACK | NACK/DTX | NACK/DTX | ACK |  | 1,0 |
| NACK/DTX | ACK | NACK/DTX | ACK |  | 0,1 |
| NACK/DTX | NACK/DTX | NACK/DTX | ACK |  | 0,0 |
| ACK | ACK | NACK/DTX | NACK/DTX |  | 1,1 |
| ACK | NACK/DTX | NACK/DTX | NACK/DTX |  | 1,0 |
| NACK/DTX | ACK | NACK/DTX | NACK/DTX |  | 0,1 |
| NACK/DTX | NACK | NACK/DTX | NACK/DTX |  | 0,0 |
| NACK | NACK/DTX | NACK/DTX | NACK/DTX |  | 0,0 |
| DTX | DTX | NACK/DTX | NACK/DTX | No Transmission | |

##### 10.1.2.2.2 PUCCH format 3 HARQ-ACK procedure

For PUCCH format 3, the UE shall use PUCCH resource  or  for transmission of HARQ-ACK in subframe/slot  for  mapped to antenna port *p* where

- for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH with DCI formats other than DCI format 7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G in subframe , or for a PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe  on the primary cell, the UE shall use PUCCH format 1a/1b and PUCCH resource  with  for antenna port , where  is the number of the first CCE (i.e. lowest CCE index used to construct the PDCCH) used for transmission of the corresponding PDCCH and  is configured by higher layers. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port  is given by .

- for a PDSCH transmission only on the primary cell where there is not a corresponding PDCCH/EPDCCH detected in subframe , the UE shall use PUCCH format 1a/1b and PUCCH resource  where the value of  is determined according to higher layer configuration and Table 9.2-2. For a UE configured for two antenna port transmission for PUCCH format 1a/1b, a PUCCH resource value in Table 9.2-2 maps to two PUCCH resources with the first PUCCH resource  for antenna port  and the second PUCCH resource  for antenna port , otherwise, the PUCCH resource value maps to a single PUCCH resource  for antenna port .

- for transmission of up to 2 HARQ-ACK bits in slot , when at least one HARQ-ACK bit is sent in response to a PDSCH transmission indicated by the detection of a corresponding PDCCH/SPDCCH with DCI format 7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G or a semi-persistently scheduled slot/subslot-PDSCH transmission or for a PDCCH/SPDCCH indicating downlink SPS release in

- slot  or

- in a subslot that is  subslots before slot or

- when scheduling request is sent in slot on a resource configured by higher layer parameter *sr-slotSPUCCH-IndexFH or sr-slotSPUCCH-IndexNoFH*,

the UE shall use PUCCH format 1a/1b and PUCCH resource  where the value of  is determined according to higher layer configuration and Table 10.1.2.1-2. For a UE configured for two antenna port transmission for PUCCH format 1a/1b, a PUCCH resource value in Table 10.1.2.1-2 maps to two PUCCH resources with the first PUCCH resource  for antenna port  and the second PUCCH resource  for antenna port , otherwise, the PUCCH resource value maps to a single PUCCH resource  for antenna port .

- for a PDSCH transmission on the secondary cell indicated by the detection of a corresponding PDCCH/EPDCCH in subframe  with DCI formats other than DCI format 7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G, the UE shall use PUCCH format 3 and PUCCH resource  where the value of  is determined according to higher layer configuration and Table 10.1.2.2.2-1.   
The TPC field in the DCI format of the corresponding PDCCH/EPDCCH shall be used to determine the PUCCH resource values from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.2-1. For a UE configured for two antenna port transmission for PUCCH format 3, a PUCCH resource value in Table 10.1.2.2.2-1 maps to two PUCCH resources with the first PUCCH resource  for antenna port  and the second PUCCH resource  for antenna port , otherwise, the PUCCH resource value maps to a single PUCCH resource  for antenna port . A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted in each DCI format of the corresponding secondary cell PDCCH/EPDCCH assignments in a given subframe.

- for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe , or for a EPDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe  on the primary cell, the UE shall use PUCCH format 1a/1b and PUCCH resource  given by

- if EPDCCH-PRB-set is configured for distributed transmission



- if EPDCCH-PRB-set is configured for localized transmission



for antenna port , where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.2.1-1,  for EPDCCH-PRB-set is configured by the higher layer parameter *pucch-ResourceStartOffset-r11 ,* for EPDCCH-PRB-set is given in Clause 6.8A.1 in [3], is determined from the antenna port used for localized EPDCCH transmission which is described in Clause 6.8A.5 in [3]. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port  is given by.

- if EPDCCH-PRB-set is configured for distributed transmission



- if EPDCCH-PRB-set is configured for localized transmission



Table 10.1.2.2.2-1: PUCCH Resource Value for HARQ-ACK Resource for PUCCH

|  |  |
| --- | --- |
| Value of 'TPC command for PUCCH'  or 'HARQ-ACK resource offset' or 'SPUCCH resource indication' field |  |
| '00' | The 1st PUCCH resource value configured by the higher layers |
| '01' | The 2nd PUCCH resource value configured by the higher layers |
| '10' | The 3rd PUCCH resource value configured by the higher layers |
| '11' | The 4th PUCCH resource value configured by the higher layers |

- for transmission of 3-11 HARQ-ACK bits on slot-PUCCH when at least one HARQ-ACK bit is sent in response to a PDSCH transmission indicated by the detection of a corresponding PDCCH/SPDCCH with DCI format 7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G or a semi-persistently scheduled slot/subslot-PDSCH transmission or for a PDCCH/SPDCCH indicating downlink SPS release in

- slot  or

- any of the subslots given in Table 10.1-1 according to the value of  when the slot-PUCCH is transmitted in subframe *m* or

- - when scheduling request is sent in slot on a resource configured by higher layer parameter *sr-slotSPUCCH-IndexFH or sr-slotSPUCCH-IndexNoFH*,

the UE shall use PUCCH format 3, if configured by higher layers, and PUCCH resource is determined according to higher layer configuration *n3SPUCCH-AN-List* and Table 10.1.2.2.2-1.

##### 10.1.2.2.3 PUCCH format 4 HARQ-ACK procedure

For PUCCH format 4, the UE shall use PUCCH resource  or  or  for transmission of HARQ-ACK and scheduling request (if any) and periodic CSI (if any) in subframe/slot/subslot  for  mapped to antenna port *p* where

- for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH with DCI formats other than DCI format 7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G in subframe , or for a PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe  on the primary cell, the UE shall use PUCCH format 1a/1b and PUCCH resource  with  for antenna port , where  is the number of the first CCE (i.e. lowest CCE index used to construct the PDCCH) used for transmission of the corresponding PDCCH and  is configured by higher layers. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port  is given by .

- for a PDSCH transmission only on the primary cell where there is not a corresponding PDCCH/EPDCCH detected in subframe , the UE shall use PUCCH format 1a/1b and PUCCH resource  where the value of  is determined according to higher layer configuration and Table 9.2-2. For a UE configured for two antenna port transmission for PUCCH format 1a/1b, a PUCCH resource value in Table 9.2-2 maps to two PUCCH resources with the first PUCCH resource  for antenna port  and the second PUCCH resource  for antenna port , otherwise, the PUCCH resource value maps to a single PUCCH resource  for antenna port .

- for transmission of up to 2 HARQ-ACK bits,

- in slot for slot-PUCCH when at least one HARQ-ACK bit is sent in response to a PDSCH transmission indicated by the detection of a corresponding PDCCH/SPDCCH with DCI format 7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G or a semi-persistently scheduled slot/subslot-PDSCH transmission or for a PDCCH/SPDCCH indicating downlink SPS release in

- slot  or

- any of the subslots given in Table 10.1-1 according to the value of  when the slot-PUCCH is transmitted in subframe *m*

- when scheduling request is sent in slot on a resource configured by higher layer parameter *sr-slotSPUCCH-IndexFH or sr-slotSPUCCH-IndexNoFH*,

the UE shall use PUCCH format 1a/1b and PUCCH resource  where the value of  is determined according to higher layer configuration and Table 10.1.2.1-2. For a UE configured for two antenna port transmission for PUCCH format 1a/1b, a PUCCH resource value in Table 10.1.2.1-2 maps to two PUCCH resources with the first PUCCH resource  for antenna port  and the second PUCCH resource  for antenna port , otherwise, the PUCCH resource value maps to a single PUCCH resource  for antenna port .

- in subslot for subslot-PUCCH when at least one HARQ-ACK bit is sent in response to a PDSCH transmission indicated by the detection of a corresponding PDCCH/SPDCCH with DCI format 7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G in subslot  or a semi-persistently scheduled subslot-PDSCH transmission in subslot  or for a PDCCH/SPDCCH indicating downlink SPS release in subslot  or when scheduling request is sent in slot on a resource configured by higher layer parameter *sr-subslotSPUCCH-Resource,* the UE shall use PUCCH resource  for transmission of HARQ-ACK in subslot  for  mapped to antenna port *p* for subslot-PUCCH transmission using format 1a/1b [3], where *PUCCH resource group is* determined by higher layer configuration and Table 10.1.2.1-3, and  is determined according to higher layer configuration and Table 10.1.2.1-4 for PUCCH format 1a, and according to higher layer configuration and Table 10.1.2.1-5 for PUCCH format 1b.

- for a PDSCH transmission on the secondary cell indicated by the detection of a corresponding PDCCH/EPDCCH in subframe  with DCI formats other than DCI format 7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G,

- if the total number of HARQ-ACK bits  and scheduling request bit (if any) and periodic CSI bits  (if any) is more than 22, the UE shall use PUCCH format 4 and PUCCH resource  where the value of  is determined according to higher layer configuration and Table 10.1.2.2.3-1.   
The TPC field in the DCI format of the corresponding PDCCH/EPDCCH shall be used to determine the PUCCH resource values from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.3-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted in each DCI format of the corresponding secondary cell PDCCH assignments in a given subframe.

- If the total number of HARQ-ACK bits  and scheduling request bit  (if any) and periodic CSI bits (if any) is no more than 22, the UE shall use PUCCH format 3 and PUCCH resourcewhere the value ofis determined according to higher layer configuration and Table 10.1.2.2.2-1. The TPC field in the DCI format of the corresponding PDCCH/EPDCCH shall be used to determine the PUCCH resource values from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.2-1. For a UE configured for two antenna port transmission for PUCCH format 3, a PUCCH resource value in Table 10.1.2.2.2-1 maps to two PUCCH resources with the first PUCCH resourcefor antenna portand the second PUCCH resourcefor antenna port, otherwise, the PUCCH resource value maps to a single PUCCH resourcefor antenna port. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted in each DCI format of the corresponding secondary cell PDCCH assignments in a given subframe.

- for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe , or for a EPDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe  on the primary cell, the UE shall use PUCCH format 1a/1b and PUCCH resource  given by

- if EPDCCH-PRB-set is configured for distributed transmission



- if EPDCCH-PRB-set is configured for localized transmission



for antenna port , where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.2.1-1,  for EPDCCH-PRB-set is configured by the higher layer parameter *pucch-ResourceStartOffset-r11 ,* for EPDCCH-PRB-set is given in Clause 6.8A.1 in [3], is determined from the antenna port used for localized EPDCCH transmission which is described in Clause 6.8A.5 in [3]. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port  is given by.

- if EPDCCH-PRB-set is configured for distributed transmission

- if EPDCCH-PRB-set is configured for localized transmission



Table 10.1.2.2.3-1: PUCCH Resource Value for HARQ-ACK Resource for PUCCH

|  |  |
| --- | --- |
| Value of 'TPC command for PUCCH'  or 'HARQ-ACK resource offset' or 'SPUCCH resource indication' field |  |
| '00' | The 1st PUCCH resource value configured by the higher layers |
| '01' | The 2nd PUCCH resource value configured by the higher layers |
| '10' | The 3rd PUCCH resource value configured by the higher layers |
| '11' | The 4th PUCCH resource value configured by the higher layers |

- for transmission of more than 2 HARQ-ACK bits, the UE shall use PUCCH format 4, and PUCCH resourceis determined according to higher layer configuration and Table 10.1.2.2.3-1,

- for slot-PUCCH and when the UE is not configured with PUCCH format 3, and at least one HARQ-ACK bit is sent in response to a PDSCH transmission indicated by the detection of a corresponding PDCCH/SPDCCH with DCI format 7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G or a semi-persistently scheduled slot-PDSCH transmission or for a PDCCH/SPDCCH indicating downlink SPS release in

- slot  or

- any of the subslots given in Table 10.1-1 according to the value of  when the slot-PUCCH is transmitted in subframe *m* or

- when scheduling request is sent in slot on a resource configured by higher layer parameter *sr-slotSPUCCH-IndexFH or sr-slotSPUCCH-IndexNoFH*,

- for subslot-PUCCH and when at least one HARQ-ACK bit is sent in response to a PDSCH transmission indicated by the detection of a corresponding PDCCH/SPDCCH with DCI format 7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G in subslot  or a semi-persistently scheduled slot-PDSCH transmission in subslot  or for a PDCCH/SPDCCH indicating downlink SPS release in subslot  or when scheduling request is sent in slot on a resource configured by higher layer parameter *sr-subslotSPUCCH-Resource*

- The UE is not expected to transmit PUCCH corresponding to 21 or 22 HARQ-ACK bits in a subslot if higher layer parameter *n4numberOfPRBSubslot* indicates single resource block for PUCCH transmission.

- for slot-PUCCH and for transmission of 12 or more HARQ-ACK bits, the UE shall use PUCCH format 4, and PUCCH resourceis determined according to higher layer configuration and Table 10.1.2.2.3-1, when the UE is configured with PUCCH format 3, and at least one HARQ-ACK bit is sent in response to a PDSCH transmission indicated by the detection of a corresponding PDCCH/SPDCCH with DCI format 7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G or a semi-persistently scheduled slot-PDSCH transmission or for a PDCCH/SPDCCH indicating downlink SPS release in

- slot  or

- any of the subslots given in Table 10.1-1 according to the value of  when the slot-PUCCH is transmitted in subframe *m* or

- when scheduling request is sent in slot on a resource configured by higher layer parameter *sr-slotSPUCCH-IndexFH or sr-slotSPUCCH-IndexNoFH*.

##### 10.1.2.2.4 PUCCH format 5 HARQ-ACK procedure

The HARQ-ACK feedback procedure for PUCCH format 5 HARQ-ACK procedure is as described in Clause 10.1.2.2.3, by replacing with .

10.1.2A FDD-TDD HARQ-ACK feedback procedures for primary cell frame structure type 1

For a UE transmitting HARQ-ACK using PUCCH format 1b with channel selection, the UE shall determine the number of HARQ-ACK bits corresponding to subframe-PDSCH,  in subframe , based on the number of configured serving cells with subframe  configured as a downlink or special subframe according to the DL-reference UL/DL configuration (defined in Clause 10.2) of each serving cell and the downlink transmission modes configured for each serving cell. For a UE not configured with PUCCH format 4/5 and transmitting HARQ-ACK using PUCCH format 3, the UE shall determine the number of HARQ-ACK bits,  in subframe , based on the number of configured serving cells with subframe  configured as a downlink or special subframe except a special subframe of configurations 0, 5 and 10 if configured by *ssp10-CRS-LessDwPTS* with normal downlink CP or of configurations 0 and 4 with extended downlink CP according to the DL-reference UL/DL configuration (defined in Clause 10.2) of each serving cell and the downlink transmission modes configured for each serving cell. The UE shall use two HARQ-ACK bits for a serving cell configured with a downlink transmission mode that support up to two transport blocks; and one HARQ-ACK bit otherwise.

A UE that supports aggregating at most 2 serving cells shall use PUCCH format 1b with channel selection for transmission of HARQ-ACK corresponding to subframe-PDSCH when configured with primary cell frame structure type 1 and secondary cell frame structure type 2.

A UE that supports aggregating more than 2 serving cells with primary cell frame structure type 1 is configured by higher layers to use either PUCCH format 1b with channel selection or PUCCH format 3/4/5 for transmission of HARQ-ACK corresponding to subframe-PDSCH when configured with more than one serving cell and primary cell frame structure type 1 and at least one secondary cell with frame structure type 2.

For HARQ-ACK transmission in subframe  with PUCCH format 1b with channel selection, the FDD-TDD HARQ-ACK procedure follows HARQ-ACK procedure described in Clause 10.1.2.1 if subframe  is an uplink or a special subframe of configurations 0, 5 and 10 if configured by *ssp10-CRS-LessDwPTS* with normal downlink CP or of configurations 0 and 4 with extended downlink CP for the secondary cell according to the higher layer parameter *subframeAssignment* for UE not configured with either higher layer parameter *EIMTA-MainConfigServCell-r12* or higher layer parameter *harq-ReferenceConfig-r14*, and according to the higher layer parameter *eimta-HARQ-ReferenceConfig-r12* for UE configured with the higher layer parameter *EIMTA-MainConfigServCell-r12*, and HARQ-ACK procedure described in Clause 10.1.2.2.1 otherwise.

The FDD-TDD HARQ-ACK feedback procedure for PUCCH format 3 HARQ-ACK procedure as described in Clause 10.1.2.2.2.

The FDD-TDD HARQ-ACK feedback procedure for PUCCH format 4 HARQ-ACK procedure is as described in Clause 10.1.2.2.3.

The FDD-TDD HARQ-ACK feedback procedure for PUCCH format 5 HARQ-ACK procedure is as described in Clause 10.1.2.2.4.

HARQ-ACK transmission on two antenna ports  is supported for PUCCH format 3.

HARQ-ACK transmission on two antenna ports  is supported for PUCCH format 1b with channel selection and with two configured serving cells.

### 10.1.3 TDD HARQ-ACK feedback procedures

For TDD and a UE that does not support aggregating more than one serving cell with frame structure type 2, two HARQ-ACK feedback modes are supported by higher layer configuration.

* HARQ-ACK bundling and
* HARQ-ACK multiplexing

For TDD and a BL/CE UE, if multiple TBs are not scheduled by a single DCI,

- if the UE is configured with *csi-NumRepetitionCE* equal to 1 and *mPDCCH-NumRepetition* equal to 1,

- the UE may be configured with HARQ-ACK bundling or HARQ-ACK multiplexing;

- HARQ-ACK multiplexing can be configured only if *pucch-NumRepetitionCE-format1* equal 1 and HARQ-ACK multiplexing is performed according to the set of Tables 10.1.3-5/6/7

- else

- the UE is not expected to receive more than one PDSCH transmission, or more than one of PDSCH and MPDCCH indicating downlink SPS releases, with transmission ending within subframe(s) , where  and  is defined in Table 10.1.3.1-1 intended for the UE;

For TDD UL/DL configuration 5 and a UE that does not support aggregating more than one serving cell with frame structure type 2 and the UE is not configured with *EIMTA-MainConfigServCell-r12* for the serving cell, only HARQ-ACK bundling is supported.

A UE that supports aggregating more than one serving cell with frame structure type 2 is configured by higher layers to use either PUCCH format 1b with channel selection or PUCCH format 3/4/5 for transmission of HARQ-ACK corresponding to subframe-PDSCH when configured with more than one serving cell with frame structure type 2.

For subframe-PUCCH and a UE that supports aggregating more than one serving cell with frame structure type 2 and is not configured with the parameter *EIMTA-MainConfigServCell-r12* for any serving cell is configured by higher layers to use HARQ-ACK bundling, PUCCH format 1b with channel selection according to the set of Tables 10.1.3-2/3/4 or according to the set of Tables 10.1.3-5/6/7, or PUCCH format 3 for transmission of HARQ-ACK when configured with one serving cell with frame structure type 2.

For subframe-PUCCH and a UE that is configured with the parameter *EIMTA-MainConfigServCell-r12* and configured with one serving cellis configured by higher layers to use PUCCH format 1b with channel selection according to the set of Tables 10.1.3-5/6/7, or PUCCH format 3 for transmission of HARQ-ACK. A UE that is configured with the parameter *EIMTA-MainConfigServCell-r12* for at least one serving cell and configured with more than one serving cell is configured by higher layers to use PUCCH format 1b with channel selection according to the set of Tables 10.1.3-5/6/7, or PUCCH format 3/4/5 for transmission of HARQ-ACK.

PUCCH format 1b with channel selection according to the set of Tables 10.1.3-2/3/4 or according to the set of Tables 10.1.3-5/6/7 is not supported for TDD UL/DL configuration 5.

TDD HARQ-ACK bundling is performed per codeword across  multiple subframes/slots in downlink or special subframes associated with a single UL subframe/slot *n*, where  is the number of elements in the set  defined in Table 10.1.3.1-1C if the UE is configured with higher layer parameter *shortTTI* for slot-PDSCH, in Table 10.1.3.1-1B if the UE is configured with higher layer parameter *shortProcessingTime* and the corresponding PDCCH with CRC scrambled by C-RNTI is in the UE-specific search space for subframe-PDSCH and in Table 10.1.3.1-1 otherwise, by a logical AND operation of all the individual PDSCH transmission (with and without corresponding PDCCH/EPDCCH/MPDCCH/SPDCCH) HARQ-ACKs and ACK in response to PDCCH/EPDCCH/MPDCCH/SPDCCH indicating downlink SPS release. For one configured serving cell the bundled 1 or 2 HARQ-ACK bits are transmitted using PUCCH format 1a or PUCCH format 1b, respectively.

For TDD HARQ-ACK multiplexing and a subframe *n* with , where  is the number of elements in the set  defined in Table 10.1.3.1-1B if the UE is configured with higher layer parameter *shortProcessingTime* and the corresponding PDCCH with CRC scrambled by C-RNTI is in the UE-specific search space for subframe-PDSCH and in Table 10.1.3.1-1 otherwise, spatial HARQ-ACK bundling across multiple codewords within a downlink or special subframe is performed by a logical AND operation of all the corresponding individual HARQ-ACKs. PUCCH format 1b with channel selection is used in case of one configured serving cell. For TDD HARQ-ACK multiplexing and a subframe *n* with , spatial HARQ-ACK bundling across multiple codewords within a downlink or special subframe is not performed, 1 or 2 HARQ-ACK bits are transmitted using PUCCH format 1a or PUCCH format 1b, respectively for one configured serving cell.

In the case of TDD and more than one configured serving cell with PUCCH format 1b with channel selection and more than 4 HARQ-ACK bits for  multiple downlink or special subframes associated with a single UL subframe *n*, where  is defined in Clause 10.1.3.2.1, and for the configured serving cells, spatial HARQ-ACK bundling across multiple codewords within a downlink or special subframe for all configured cells is performed and the bundled HARQ-ACK bits for each configured serving cell is transmitted using PUCCH format 1b with channel selection. For TDD and more than one configured serving cell with PUCCH format 1b with channel selection and up to 4 HARQ-ACK bits for multiple downlink or special subframes associated with a single UL subframe *n*, where  is defined in Clause 10.1.3.2.1, and for the configured serving cells, spatial HARQ-ACK bundling is not performed and the HARQ-ACK bits are transmitted using PUCCH format 1b with channel selection.

In the case of TDD and more than one configured serving cell with PUCCH format 3 and without PUCCH format 4/5 configured and more than 20 HARQ-ACK bits for  multiple downlink or special subframes associated with a single UL subframe *n*, where  is the number of elements in the set  defined in Clause 10.1.3.2.2 and for the configured serving cells, spatial HARQ-ACK bundling across multiple codewords within a downlink or special subframe is performed for each serving cell by a logical AND operation of all of the corresponding individual HARQ-ACKs and PUCCH format 3 is used. For TDD and more than one configured serving cell with PUCCH format 3 and up to 20 HARQ-ACK bits for  multiple downlink or special subframes associated with a single UL subframe *n*, where  is the number of elements in the set  defined in Clause 10.1.3.2.2 and for the configured serving cells, spatial HARQ-ACK bundling is not performed and the HARQ-ACK bits are transmitted using PUCCH format 3.

For TDD with PUCCH format 3 without PUCCH format 4/5 configured, a UE shall determine the number of HARQ-ACK bits, , associated with an UL subframe/slot *n*

according to  where  is the number of configured cells, and is the number of HARQ-bits for the *c*-th serving cell defined in Clause 7.3.

TDD HARQ-ACK feedback procedures for one configured serving cell are given in Clause 10.1.3.1 and procedures for more than one configured serving cell are given in Clause 10.1.3.2.

#### 10.1.3.1 TDD HARQ-ACK procedure for one configured serving cell

HARQ-ACK transmission on two antenna ports  is supported for PUCCH format 1a/1b with TDD HARQ-ACK bundling feedback mode and for PUCCH format 3.

A UE that supports aggregating more than one serving cell with frame structure type 2 can be configured by higher layers for HARQ-ACK transmission on two antenna ports  for PUCCH format 1b with channel selection.

The TDD HARQ-ACK procedure for a UE configured with PUCCH format 3 is as described in Clause 10.1.3.2.2 when the UE receives PDSCH and/or SPS release PDCCH/EPDCCH only on the primary cell.

If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12,* and the UE is not configured with the higher layer parameter *shortProcessingTime*, for TDD HARQ-ACK bundling or TDD HARQ-ACK multiplexing for one configured serving cell and a subframe *n* with  where  is the number of elements in the set  defined in Table 10.1.3.1-1, the UE shall use PUCCH resource  for transmission of HARQ-ACK in subframe  for  mapped to antenna port *p* for PUCCH format 1a/1b, where

- If there is PDSCH transmission indicated by the detection of corresponding PDCCH/EPDCCH or there is PDCCH/EPDCCH indicating downlink SPS release within subframe(s) , where  and  (defined in Table 10.1.3.1-1) is a set of *M* elements  depending on the subframe *n* and the UL/DL configuration (defined in Table 4.2-2 in [3]), and if PDCCH indicating PDSCH transmission or downlink SPS release is detected in subframe , where  is the smallest value in set such that UE detects a PDCCH/EPDCCH indicating PDSCH transmission or downlink SPS release within subframe(s)  and , the UE first selects a  value out of {0, 1, 2, 3} which makes  and shall use  for antenna port , where  is configured by higher layers, , and  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe and the corresponding *m*. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for HARQ-ACK bundling for antenna port  is given by  .

- For a non-BL/CE UE and if there is only a PDSCH transmission where there is not a corresponding PDCCH/EPDCCH detected within subframe(s) , where and  is defined in Table 10.1.3.1-1, the UE shall use PUCCH format 1a/1b and PUCCH resource  with the value of  is determined according to higher layer configuration and Table 9.2-2. For a UE configured for two antenna port transmission for PUCCH format 1a/1b and HARQ-ACK bundling, a PUCCH resource value in Table 9.2-2 maps to two PUCCH resources with the first PUCCH resource for antenna port  and the second PUCCH resource for antenna port , otherwise, the PUCCH resource value maps to a single PUCCH resource for antenna port .

- If there is PDSCH transmission indicated by the detection of corresponding PDCCH/EPDCCH or there is PDCCH/EPDCCH indicating downlink SPS release within subframe(s) , where  and  (defined in Table 10.1.3.1-1) is a set of *M* elements  depending on the subframe *n* and the UL/DL configuration (defined in Table 4.2-2 in [3]), and if EPDCCH indicating PDSCH transmission or downlink SPS release is detected in subframe , where  is the smallest value in set such that UE detects a PDCCH/EPDCCH indicating PDSCH transmission or downlink SPS release within subframe(s)  and , the UE shall use

- if EPDCCH-PRB-set is configured for distributed transmission



- if EPDCCH-PRB-set is configured for localized transmission



for antenna port , where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe  and the corresponding *m*,  for EPDCCH-PRB-set is configured by the higher layer parameter *pucch-ResourceStartOffset-r11 ,* for EPDCCH-PRB-set in subframe is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3]. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.2.1-1. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.3.1-2. If the UE is configured to monitor EPDCCH in subframe ,  is equal to the number of ECCEs in EPDCCH-PRB-set configured for that UE in subframe. If the UE is not configured to monitor EPDCCH in subframe ,  is equal to the number of ECCEs computed assuming EPDCCH-PRB-set is configured for that UE in subframe . For normal downlink CP, if subframe  is a special subframe with special subframe configuration 0, 5 or 10 if configured by *ssp10-CRS-LessDwPTS*, is equal to 0. For extended downlink CP, if subframe  is a special subframe with special subframe configuration 0 or 4 or 7, is equal to 0. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for HARQ-ACK bundling for antenna port  is given by

- if EPDCCH-PRB-set is configured for distributed transmission



- if EPDCCH-PRB-set is configured for localized transmission



- For a BL/CE UE, if there is only a PDSCH transmission within one or more consecutive BL/CE downlink subframe(s) where subframe , is the last subframe in which the PDSCH is transmitted where and  is defined in Table 10.1.3.1-1 and there is not a corresponding MPDCCH, the UE shall use PUCCH format 1a and PUCCH resource  where the value of is determined according to higher layer configuration and Table 9.2-2.

- If there is PDSCH transmission indicated by the detection of corresponding MPDCCH or there is MPDCCH indicating downlink SPS release within subframe(s) , where  and  (defined in Table 10.1.3.1-1) is a set of *M* elements  depending on the subframe *n* and the UL/DL configuration (defined in Table 4.2-2 in [3]) and subframe  is the last subframe in which the PDSCH or MPDCCH indicating downlink SPS release is transmitted and there is no  where  and subframe  is the last subframe in which a PDSCH indicated by the detection of corresponding MPDCCH or MPDCCH indicating downlink SPS release is transmitted, the UE shall use

- if MPDCCH-PRB-set is configured for distributed transmission



- if MPDCCH-PRB-set is configured for localized transmission



for antenna port , where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the MPDCCH) used for transmission of the corresponding DCI assignment in MPDCCH-PRB-set ,  for MPDCCH-PRB-set  is configured

- by the higher layer parameter *n1PUCCH-AN-r13*, if configured; otherwise:

- by the higher layer parameter *n1PUCCH-AN-InfoList-r13* for the corresponding CE level*,*

for MPDCCH-PRB-set  is given in Clause 6.8A.1 in [3], is determined from the antenna port used for the MPDCCH transmission which is described in Clause 6.8A.5 in [3]. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding MPDCCH as given in Table 10.1.2.1-1. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding MPDCCH as given in Table 10.1.3.1-2. If subframe  is a BL/CE downlink subframe,  is equal to the number of ECCEs in MPDCCH-PRB-set configured for that UE in subframe. If subframe  is not a BL/CE downlink subframe,  is equal to 0. If subframe  is a BL/CE downlink special subframe in which MPDCCH is not supported, the UE shall calculate  by assuming for normal cyclic prefix and for extended cyclic prefix. If an MPDCCH-PRB-set is 2+4, then . When an MPDCCH-PRB-set is 2+4, following procedures is applied.

- if the detected MPDCCH is located within 2 PRB set, is obtained by above procedure.

- if the detected MPDCCH is located within 4 PRB set, is the sum between and the value obtained by above procedure.

- if the detected MPDCCH is MPDCCH format 5, is obtained by the above procedure with  = 0.

Table 10.1.3.1-1: Downlink association set *:*  for TDD

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL/DL  Configuration | Subframe *n* | | | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 0 | - | - | 6 | - | 4 | - | - | 6 | - | 4 |
| 1 | - | - | 7, 6 | 4 | - | - | - | 7, 6 | 4 | - |
| 2 | - | - | 8, 7, 4, 6 | - | - | - | - | 8, 7, 4, 6 | - | - |
| 3 | - | - | 7, 6, 11 | 6, 5 | 5, 4 | - | - | - | - | - |
| 4 | - | - | 12, 8, 7, 11 | 6, 5, 4, 7 | - | - | - | - | - | - |
| 5 | - | - | 13, 12, 9, 8, 7, 5, 4, 11, 6 | - | - | - | - | - | - | - |
| 6 | - | - | 7 | 7 | 5 | - | - | 7 | 7 | - |

Table 10.1.3.1-1A: eIMTA downlink association set *:* for TDD

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Higher layer parameter  '*eimta-HARQ-ReferenceConfig-r12*' | Higher layer parameter '*subframeAssignment*' | Subframe *n* | | | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 2 | 0 | - | - | 7,8,4 | - | - | - | - | 7,8,4 | - | - |
| 1 | - | - | 8,4 | - | - | - | - | 8,4 | - | - |
| 6 | - | - | 6,8,4 | - | - | - | - | 8,6,4 | - | - |
| 4 | 0 | - | - | 12,7,11,8 | 7,4,5,6 | - | - | - | - | - | - |
| 1 | - | - | 12,8,11 | 7,5,6 | - | - | - | - | - | - |
| 3 | - | - | 12,8 | 4,7 | - | - | - | - | - | - |
| 6 | - | - | 12,11,8 | 4,5,6 | - | - | - | - | - | - |
| 5 | 0 | - | - | 12,7,11,13,8,4,9,5 | - | - | - | - | - | - | - |
| 1 | - | - | 13,12,8,11,4,9,5 | - | - | - | - | - | - | - |
| 2 | - | - | 13,12,9,11,5 | - | - | - | - | - | - | - |
| 3 | - | - | 13,12,5,4,8,9 | - | - | - | - | - | - | - |
| 4 | - | - | 13,5,4,6,9 | - | - | - | - | - | - | - |
| 6 | - | - | 13,12,11,6,8,4,9,5 | - | - | - | - | - | - | - |

Table 10.1.3.1-1B: Downlink association set *:* for TDD and UE configured with higher layer parameter *shortProcessingTime*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL/DL  Configuration | Subframe *n* | | | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 0 | - | - | - | 3 | 3 | - | - | - | 3 | 3 |
| 1 | - | - | 3 | 3 | - | - | - | 3 | 3 | - |
| 2 | - | - | 3 | - | - | - | - | 3 | - | - |
| 3 | - | - | 5 | 4 | 3 | - | - | - | - | - |
| 4 | - | - | 6 | 3 | - | - | - | - | - | - |
| 5 | - | - | 3 | - | - | - | - | - | - | - |
| 6 | - | - | 6 | 4 | 4 | - | - | 6 | 3 | - |

Table 10.1.3.1-1C: Downlink association set *:*  for TDD with special subframe configuration 1, 2, 6, 7 and UE configured with higher layer parameter *shortTTI*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL/DL  Configuration | slot *n* | | | | | | | | | | | | | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 0 |  |  |  |  | 4 | 4 | 4 |  |  |  |  |  |  |  | 4 | 4 | 4 |  |  |  |
| 1 |  |  |  |  | 6,5 | 5,4 | 4 |  |  |  |  |  |  |  | 6,5 | 5,4 | 4 |  |  |  |
| 2 |  |  |  |  | 8,7,  12 | 7,6,  5,4 |  |  |  |  |  |  |  |  | 8,7,12 | 7,6,5,4 |  |  |  |  |
| 3 |  |  |  |  | 14,  13,  12 | 12,11,  10 | 10,9 | 9,8 | 8,7 | 7 |  |  |  |  |  |  |  |  |  |  |
| 4 |  |  |  |  | 16,  15,  14,  13 | 13,12,  11,10 | 10,9,  8,7 | 7,6,5 |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  | 18,  17,  16,  15,  14,  13,  12,22 | 12,11,  10,9,  8,7,6,5,4 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 |  |  |  |  | 6 | 6 | 6 | 6 | 6 |  |  |  |  |  | 4 | 4 | 4 |  |  |  |

Table 10.1.3.1-1D: Downlink association set *:*  for TDD with special subframe configuration 3, 4 or 8 and UE configured with higher layer parameter *shortTTI*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UL/DL**  **Configuration** | **slot *n*** | | | | | | | | | | | | | | | | | | | |
| **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** |
| 0 |  |  |  |  | 4 | 4 | 4 | 4 |  |  |  |  |  |  | 4 | 4 | 4 | 4 |  |  |
| 1 |  |  |  |  | 6,5 | 5,4 | 4 | 4 |  |  |  |  |  |  | 6,5 | 5,4 | 4 | 4 |  |  |
| 2 |  |  |  |  | 8,7,  12,11 | 7,6,  5,4 |  |  |  |  |  |  |  |  | 8,7,12,11 | 7,6,5,4 |  |  |  |  |
| 3 |  |  |  |  | 14,  13,  12 | 12,11,  10 | 10,9 | 9,8 | 8,7 | 7,6 |  |  |  |  |  |  |  |  |  |  |
| 4 |  |  |  |  | 16,  15,  14,  13 | 13,12,  11,10 | 10,9,  8,7 | 7,6,5,4 |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  | 18,  17,  16,  15,  14,  13,  12,22,21 | 12,11,  10,9,  8,7,6,5,4 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 |  |  |  |  | 6 | 6 | 6 | 6 | 6 | 6 |  |  |  |  | 4 | 4 | 4 | 4 |  |  |

Table 10.1.3.1-1E: Downlink association set *:*  for TDD with special subframe configuration 0, 5, 9, 10 and UE configured with higher layer parameter *shortTTI*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL/DL  Configuration | slot *n* | | | | | | | | | | | | | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 0 |  |  |  |  | 4 | 4 | 4 |  |  |  |  |  |  |  | 4 | 4 | 4 |  |  |  |
| 1 |  |  |  |  | 6,5 | 5 | 5 | 5 |  |  |  |  |  |  | 6,5 | 5 | 5 | 5 |  |  |
| 2 |  |  |  |  | 8,7,  12 | 7,6,  5,4 |  |  |  |  |  |  |  |  | 8,7,12 | 7,6,5,4 |  |  |  |  |
| 3 |  |  |  |  | 14,  13,  12 | 12,11,  10 | 10,9 | 9,8 | 8,7 | 7 |  |  |  |  |  |  |  |  |  |  |
| 4 |  |  |  |  | 16,  15,  14,  13 | 13,12,  11,10 | 10,9,  8,7 | 7,6,5 |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  | 18,  17,  16,  15,  14,  13,  12,22 | 12,11,  10,9,  8,7,6,5,4 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 |  |  |  |  | 6,5 |  | 6,5 |  | 6 |  |  |  |  |  | 4 | 4 | 4 |  |  |  |

Table 10.1.3.1-2: Mapping of ACK/NACK Resource offset Field in DCI format 1A/1B/1D/1/2A/2/2B/2C/2D/6-1A/6-1B to values for TDD when 

|  |  |
| --- | --- |
| ACK/NACK Resource offset field in  DCI format 1A/1B/1D/1/2A/2/2B/2C/2D |  |
| 0 | 0 |
| 1 |  |
| 2 |  |
| 3 | 2 |

Table 10.1.3.1-3: Mapping of ACK/NACK Resource offset Field in DCI format 1A/1B/1D/1/2A/2/2B/2C/2D to values for TDD when and 

|  |  |
| --- | --- |
| ACK/NACK Resource offset field in  DCI format 1A/1B/1D/1/2A/2/2B/2C/2D |  |
| 0 | 0 |
| 1 |  |
| 2 |  |
| 3 | 2 |

If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12,* and the UE is not configured with the higher layer parameter *shortProcessingTime,* for TDD HARQ-ACK multiplexing and sub-frame  with  and one configured serving cell, where  is the number of elements in the set  defined in Table 10.1.3.1-1, denote  as the PUCCH resource derived from sub-frame  and HARQ-ACK(i) as the ACK/NACK/DTX response from sub-frame , where (defined in Table 10.1.3.1-1) and .

- For a PDSCH transmission indicated by the detection of corresponding PDCCH or a PDCCH indicating downlink SPS release in sub-frame  where , the PUCCH resource , where  is selected from {0, 1, 2, 3} such that , ,  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe , and  is configured by higher layers.

- For a PDSCH transmission where there is not a corresponding PDCCH/EPDCCH detected in subframe , the value of  is determined according to higher layer configuration and Table 9.2-2.

- For a non-BL/CE UE and for a PDSCH transmission indicated by the detection of corresponding EPDCCH or a EPDCCH indicating downlink SPS release in sub-frame  where , the UE shall use

- if EPDCCH-PRB-set is configured for distributed transmission



- if EPDCCH-PRB-set is configured for localized transmission



where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter *pucch-ResourceStartOffset-r11 ,* for EPDCCH-PRB-set in subframe is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3]. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.2.1-1. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.3.1-2, where the variable in the table is substituted with . If the UE is configured to monitor EPDCCH in subframe ,  is equal to the number of ECCEs in EPDCCH-PRB-set configured for that UE in subframe . If the UE is not configured to monitor EPDCCH in subframe ,  is equal to the number of ECCEs computed assuming EPDCCH-PRB-set is configured for that UE in subframe . For normal downlink CP, if subframe  is a special subframe with special subframe configuration 0, 5 or 10 if configured by *ssp10-CRS-LessDwPTS*, is equal to 0. For extended downlink CP, if subframe  is a special subframe with special subframe configuration 0 or 4 or 7, is equal to 0.

- For a BL/CE UE, for a PDSCH transmission detected in subframe without a corresponding MPDCCH, the value of  is determined according to higher layer configuration and Table 9.2-2.

- For a BL/CE UE, for a PDSCH transmission in sub-frame  where  indicated by the detection of corresponding MPDCCH or a MPDCCH indicating downlink SPS release in sub-frame  where , the UE shall use

- if MPDCCH-PRB-set is configured for distributed transmission



- if MPDCCH-PRB-set is configured for localized transmission



where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the MPDCCH) used for transmission of the corresponding DCI assignment in MPDCCH-PRB-set ,  for MPDCCH-PRB-set  is configured

- by the higher layer parameter *n1PUCCH-AN-r13*, if configured; otherwise:

- by the higher layer parameter *n1PUCCH-AN-InfoList-r13* for the corresponding CE level*,*

 for MPDCCH-PRB-set  is given in Clause 6.8A.1 in [3], is determined from the antenna port used for the MPDCCH transmission which is described in Clause 6.8A.5 in [3]. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding MPDCCH as given in Table 10.1.2.1-1. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding MPDCCH as given in Table 10.1.3.1-2, where the variable in the table is substituted with . If subframe  is a BL/CE downlink subframe,  is equal to the number of ECCEs in MPDCCH-PRB-set configured for that UE in subframe. If subframe  is not a BL/CE downlink subframe,  is equal to 0. If subframe  is a BL/CE downlink special subframe in which MPDCCH is not supported, the UE shall calculate  by assuming for normal cyclic prefix and for extended cyclic prefix. If an MPDCCH-PRB-set is 2+4, then . When an MPDCCH-PRB-set is 2+4, following procedures is applied.

- if the detected MPDCCH is located within 2 PRB set, is obtained by above procedure.

- if the detected MPDCCH is located within 4 PRB set, is the sum between and the value obtained by above procedure.

- if the detected MPDCCH is MPDCCH format 5, is obtained by the above procedure with  = 0.

If a UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12*, or the UE is configured with the higher layer parameter *shortProcessingTime*, then where the set is defined in Table 10.1.3.1-1B if the UE is configured with higher layer parameter *shortProcessingTime* and the corresponding PDCCH with CRC scrambled by C-RNTI is in the UE-specific search space for subframe-PDSCH and in Table 10.1.3.1-1 otherwise (where "UL/DL configuration" in the table refers to the higher layer parameter *subframeAsssignment* if the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12*), and is the number of elements in set .

If a UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12*, or the UE is configured with the higher layer parameter *shortProcessingTime*, then the set for the rest of this Clause is as defined in Clause 10.2, and is the number of elements for subframe *n* in the set 

If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12*, or the UE is configured with the higher layer parameter *shortProcessingTime,* for TDD HARQ-ACK multiplexing and sub-frame , denote  as the PUCCH resource derived from sub-frame and HARQ-ACK(i0) as the ACK/NACK/DTX response from sub-frame, where , and .

-  corresponding to each subframe , is determined as follows

Set ;

for 

if the value of  is the same as the value of an element  in set , where ,

corresponding to subframe =;



end if

end for

for 

if the value of is same as the value of an element  in set , where  (defined in Table 10.1.3.1-1A if the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12*, or Table 10.1.3.1-1B if the UE is configured with the higher layer parameter *shortProcessingTime*)

 corresponding to subframe =;



end if

end for

- For a PDSCH transmission indicated by the detection of corresponding PDCCH or a PDCCH indicating downlink SPS release in sub-frame ,

- if the value of is same as the value of an element in set , the PUCCH resource  is given by ;

- if the value of is same as the value of an element  in set , where (defined in Table 10.1.3.1-1A if the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12*), the PUCCH resource  is given by ;

- if the value of  is same as the value of an element  in set , where (defined in Table 10.1.3.1-1B if the UE is configured with the higher layer parameter *shortProcessingTime*), the PUCCH resource  is given by ;

where  is the number of elements in the set  defined in Table 10.1.3.1-1A if the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12*, or Table 10.1.3.1-1B if the UE is configured with the higher layer parameter *shortProcessingTime*,  is selected from {0, 1, 2, 3} such that , ,  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe , and , , are configured by higher layers.

- For a PDSCH transmission where there is not a corresponding PDCCH/EPDCCH detected in subframe , the value of  is determined according to higher layer configuration and Table 9.2-2.

- For a PDSCH transmission indicated by the detection of corresponding EPDCCH or a EPDCCH indicating downlink SPS release in sub-frame  where , the UE shall use

- if EPDCCH-PRB-set is configured for distributed transmission  


- if EPDCCH-PRB-set is configured for localized transmission  


where

- if the value of is same as the value of an index , where , then and ;

- otherwise, if the value of is same as the value of an index , where , then and ;

, and where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter *pucch-ResourceStartOffset-r11 ,* for EPDCCH-PRB-set in subframe  is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe  which is described in Clause 6.8A.5 in [3].

 is determined as follows

- If  and ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.2.1-1.

- If  and ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.3.1-2, where the variable in the table is substituted with, the variable in the table is substituted with , the variable  in the table is substituted with and the variable in the table is substituted with .

- If  and ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.3.1-3,

For a given subframe ,  is determined as follows

- If the UE is configured to monitor EPDCCH in subframe ,  is equal to the number of ECCEs in EPDCCH-PRB-set configured for that UE in subframe .

- If the UE is not configured to monitor EPDCCH in subframe ,  is equal to the number of ECCEs computed assuming EPDCCH-PRB-set is configured for that UE in subframe .

- For normal downlink CP, if subframe  is a special subframe with special subframe configuration 0, 5 or 10 if configured by *ssp10-CRS-LessDwPTS*,  is equal to 0.

- For extended downlink CP, if subframe  is a special subframe with special subframe configuration 0 or 4 or 7,  is equal to 0.

For a non-BL/CE UE, if the UE is not configured with two antenna port transmission for PUCCH format 1b with channel selection, and if the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12,* based on higher layer signalling the UE configured with a single serving cell will perform channel selection either according to the set of Tables 10.1.3-2, 10.1.3-3, and 10.1.3-4 or according to the set of Tables 10.1.3-5, 10.1.3-6, and 10.1.3-7.

If a UE is configured with two antenna port transmission for PUCCH format 1b with channel selection, and if the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12,* then the UE will perform channel selection according to the set of Tables 10.1.3-5, 10.1.3-6, and 10.1.3-7.

If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12,* the UE configured with a single serving cell will perform channel selection according to the set of Tables 10.1.3-5, 10.1.3-6, and 10.1.3-7.

For the selected table set, the UE shall transmit  on PUCCH resource in sub-frame  for  mapped to antenna port  using PUCCH format 1b according to Clause 5.4.1 in [3] where

- =for antenna port and the value of  and the PUCCH resource  are generated by channel selection according to the selected set of Tables for *M* = 2, 3, and 4 respectively

-  for antenna port, where  is selected from PUCCH resources configured by higher layers where , according to selected set of Tables for *M* = 2, 3, and 4 respectively by replacing with and replacing  with , when the UE is configured with two antenna port transmission for PUCCH format 1b with channel selection.

Table 10.1.3-2: Transmission of HARQ-ACK multiplexing for *M* = 2

|  |  |  |
| --- | --- | --- |
| HARQ-ACK(0), HARQ-ACK(1) |  |  |
| ACK, ACK |  | 1, 1 |
| ACK, NACK/DTX |  | 0, 1 |
| NACK/DTX, ACK |  | 0, 0 |
| NACK/DTX, NACK |  | 1, 0 |
| NACK, DTX |  | 1, 0 |
| DTX, DTX | No transmission | |

Table 10.1.3-3: Transmission of HARQ-ACK multiplexing for *M* = 3

|  |  |  |
| --- | --- | --- |
| HARQ-ACK(0), HARQ-ACK(1), HARQ-ACK(2) |  |  |
| ACK, ACK, ACK |  | 1, 1 |
| ACK, ACK, NACK/DTX |  | 1, 1 |
| ACK, NACK/DTX, ACK |  | 1, 1 |
| ACK, NACK/DTX, NACK/DTX |  | 0, 1 |
| NACK/DTX, ACK, ACK |  | 1, 0 |
| NACK/DTX, ACK, NACK/DTX |  | 0, 0 |
| NACK/DTX, NACK/DTX, ACK |  | 0, 0 |
| DTX, DTX, NACK |  | 0, 1 |
| DTX, NACK, NACK/DTX |  | 1, 0 |
| NACK, NACK/DTX, NACK/DTX |  | 1, 0 |
| DTX, DTX, DTX | No transmission | |

Table 10.1.3-4: Transmission of HARQ-ACK multiplexing for *M* = 4

|  |  |  |
| --- | --- | --- |
| HARQ-ACK(0), HARQ-ACK(1), HARQ-ACK(2), HARQ-ACK(3) |  |  |
| ACK, ACK, ACK, ACK |  | 1, 1 |
| ACK, ACK, ACK, NACK/DTX |  | 1, 0 |
| NACK/DTX,NACK/DTX,NACK,DTX |  | 1, 1 |
| ACK, ACK, NACK/DTX, ACK |  | 1, 0 |
| NACK, DTX, DTX, DTX |  | 1, 0 |
| ACK, ACK, NACK/DTX, NACK/DTX |  | 1, 0 |
| ACK, NACK/DTX, ACK, ACK |  | 0, 1 |
| NACK/DTX, NACK/DTX, NACK/DTX, NACK |  | 1, 1 |
| ACK, NACK/DTX, ACK, NACK/DTX |  | 0, 1 |
| ACK, NACK/DTX, NACK/DTX, ACK |  | 0, 1 |
| ACK, NACK/DTX, NACK/DTX, NACK/DTX |  | 1, 1 |
| NACK/DTX, ACK, ACK, ACK |  | 0, 1 |
| NACK/DTX, NACK, DTX, DTX |  | 0, 0 |
| NACK/DTX, ACK, ACK, NACK/DTX |  | 1, 0 |
| NACK/DTX, ACK, NACK/DTX, ACK |  | 1, 0 |
| NACK/DTX, ACK, NACK/DTX, NACK/DTX |  | 0, 1 |
| NACK/DTX, NACK/DTX, ACK, ACK |  | 0, 1 |
| NACK/DTX, NACK/DTX, ACK, NACK/DTX |  | 0, 0 |
| NACK/DTX, NACK/DTX, NACK/DTX, ACK |  | 0, 0 |
| DTX, DTX, DTX, DTX | No transmission | |

Table 10.1.3-5: Transmission of HARQ-ACK multiplexing for *M* = 2

|  |  |  |
| --- | --- | --- |
| HARQ-ACK(0), HARQ-ACK(1) |  |  |
| ACK, ACK |  | 1, 0 |
| ACK, NACK/DTX |  | 1, 1 |
| NACK/DTX, ACK |  | 0, 1 |
| NACK, NACK/DTX |  | 0, 0 |
| DTX, NACK/DTX | No Transmission | |

Table 10.1.3-6: Transmission of HARQ-ACK multiplexing for *M* = 3

|  |  |  |
| --- | --- | --- |
| HARQ-ACK(0), HARQ-ACK(1), HARQ-ACK(2) |  |  |
| ACK, ACK, ACK |  | 1, 1 |
| ACK, ACK, NACK/DTX |  | 1, 0 |
| ACK, NACK/DTX, ACK |  | 1, 0 |
| ACK, NACK/DTX, NACK/DTX |  | 1, 1 |
| NACK/DTX, ACK, ACK |  | 0, 1 |
| NACK/DTX, ACK, NACK/DTX |  | 0, 1 |
| NACK/DTX, NACK/DTX, ACK |  | 0, 0 |
| NACK, NACK/DTX, NACK/DTX |  | 0, 0 |
| DTX, NACK/DTX, NACK/DTX | No Transmission | |

Table 10.1.3-7: Transmission of HARQ-ACK multiplexing for *M* = 4

|  |  |  |
| --- | --- | --- |
| HARQ-ACK(0), HARQ-ACK(1), HARQ-ACK(2), HARQ-ACK(3) |  |  |
| ACK, ACK, ACK, ACK |  | 1, 1 |
| ACK, ACK, ACK, NACK/DTX |  | 1, 1 |
| ACK, ACK, NACK/DTX, ACK |  | 1, 0 |
| ACK, ACK, NACK/DTX, NACK/DTX |  | 1, 0 |
| ACK, NACK/DTX, ACK, ACK |  | 1, 1 |
| ACK, NACK/DTX, ACK, NACK/DTX |  | 1, 0 |
| ACK, NACK/DTX, NACK/DTX, ACK |  | 0, 1 |
| ACK, NACK/DTX, NACK/DTX, NACK/DTX |  | 1, 1 |
| NACK/DTX, ACK, ACK, ACK |  | 0, 0 |
| NACK/DTX, ACK, ACK, NACK/DTX |  | 0, 1 |
| NACK/DTX, ACK, NACK/DTX, ACK |  | 1, 0 |
| NACK/DTX, ACK, NACK/DTX, NACK/DTX |  | 0, 1 |
| NACK/DTX, NACK/DTX, ACK, ACK |  | 0, 1 |
| NACK/DTX, NACK/DTX, ACK, NACK/DTX |  | 0, 0 |
| NACK/DTX, NACK/DTX, NACK/DTX, ACK |  | 0, 0 |
| NACK, NACK/DTX, NACK/DTX, NACK/DTX |  | 0, 0 |
| DTX, NACK/DTX, NACK/DTX, NACK/DTX | No Transmission | |

#### 10.1.3.2 TDD HARQ-ACK procedure for more than one configured serving cell

If a UE configured with *EIMTA-MainConfigServCell-r12* for a serving cell, "UL/DL configuration" of the serving cell in the rest of this Clause refers to the UL/DL configuration given by the parameter *eimta-HARQ-ReferenceConfig-r12* for the serving cell unless specified otherwise.

For TDD serving cell not configured for PUSCH/PUCCH transmission, "UL/DL configuration" of the serving cell in the rest of this Clause refers to the UL/DL configuration given by the parameter *harq-ReferenceConfig-r14* for the serving cell unless specified otherwise.

The TDD HARQ-ACK feedback procedures for more than one configured serving cell are either based on a PUCCH format 1b with channel selection HARQ-ACK procedure as described in Clause 10.1.3.2.1 or a PUCCH format 3 HARQ-ACK procedure as described in Clause 10.1.3.2.2 or a PUCCH format 4 HARQ-ACK procedure as described in Clause 10.1.3.2.3 or a PUCCH format 5 HARQ-ACK procedure as described in Clause 10.1.3.2.4.

HARQ-ACK transmission on two antenna ports  is supported for PUCCH format 3 and TDD with more than one configured serving cell.

If a UE is configured with more than one serving cell and the TDD UL/DL configurations of all serving cells are the same, TDD UL/DL configuration 5 with PUCCH format 3 is only supported for up to two configured serving cells.   
If a UE is configured with two serving cells and the TDD UL/DL configuration of the two serving cells is the same, TDD UL/DL configuration 5 with PUCCH format 1b with channel selection for two configured serving cells is not supported. If a UE is configured with two serving cells and if the TDD UL/DL configuration of the two serving cells are not the same and if the DL-reference UL/DL configuration (as defined in Clause 10.2) of at least one serving cell is TDD UL/DL Configuration 5, PUCCH format 1b with channel selection is not supported.

If a UE is configured with the parameter *EIMTA-MainConfigServCell-r12* for at least one serving cell and is configured with PUCCH format 3 without PUCCH format 4/5 configured, the UE is not expected to be configured with more than two serving cells having UL/DL Configuration 5 as a DL-reference UL/DL configuration.

HARQ-ACK transmission on two antenna ports  is supported for PUCCH format 1b with channel selection and TDD with two configured serving cells.

##### 10.1.3.2.1 PUCCH format 1b with channel selection HARQ-ACK procedure

If a UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12*, then where the set  is defined in Table 10.1.3.1-1 (where "UL/DL configuration" in the table refers to the higher layer parameter *subframeAssignment*), and is the number of elements in set .

If a UE is configured with two serving cells with the same UL/DL configurations, then in the rest of this clause,  is as defined in Clause 10.2 and is the number of elements for subframe *n* in the set , and .

If a UE is configured with two serving cells with different UL/DL configurations,

- then the UE shall determine  for a subframe *n* in this Clause as, where

-  denotes the number of elements for subframe *n* in the set  for the primary cell (as defined in Clause 10.2)

-  denotes the number of elements for subframe *n* in the set for the secondary serving cell (as defined in Clause 10.2)

- if , then the UE shall, for the secondary serving cell, set HARQ-ACK(j) to DTX for *j* = to .

- if , then the UE shall, for the primary cell, set HARQ-ACK(j) to DTX for *j* =  to 

If the UE is configured with two serving cells with different UL/DL configurations, then in the rest of this Clause,  = where is defined in Clause 10.2.

For TDD HARQ-ACK multiplexing with PUCCH format 1b with channel selection and two configured serving cells and a subframe *n* with , a UE shall determine the number of HARQ-ACK bits, , based on the number of configured serving cells and the downlink transmission modes configured for each serving cell. The UE shall use two HARQ-ACK bits for a serving cell configured with a downlink transmission mode that supports up to two transport blocks; and one HARQ-ACK bit otherwise.

For TDD HARQ-ACK multiplexing with PUCCH format 1b with channel selection and two configured serving cells and a subframe *n* with , the UE shall transmit  on PUCCH resource  for  mapped to antenna port *p* using PUCCH format 1b where

-  =  for antenna port , where  selected from  PUCCH resources,  where  and, according to Tables 10.1.3.2-1, 10.1.3.2-2, and 10.1.3.2-3 in subframe using PUCCH format 1b.

-  for antenna port, where  selected from  PUCCH resources, configured by higher layers where  and, according to Tables 10.1.3.2-1, 10.1.3.2-2, and 10.1.3.2-3 by replacing with and replacing  with  in subframe , when the UE is configured with two antenna port transmission for PUCCH format 1b with channel selection,

and for a subframe *n* with , HARQ-ACK(*j*) denotes the ACK/NACK/DTX response for a transport block or SPS release PDCCH/EPDCCH associated with serving cell, where the transport block and serving cell for HARQ-ACK(*j*) and  PUCCH resources are given by Table 10.1.2.2.1-1. For a subframe *n* with , HARQ-ACK(*j*) denotes the ACK/NACK/DTX response for a PDSCH transmission or SPS release PDCCH/EPDCCH within subframe(s) given by set  on each serving cell, where the subframes on each serving cell for HARQ-ACK(*j*) and  PUCCH resources are given by Table 10.1.3.2-4.

If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12,* the UE shall determine the  PUCCH resources,  associated with HARQ-ACK(*j*) where  in Table 10.1.2.2.1-1 for  and Table 10.1.3.2-4 for , according to

- for a PDSCH transmission indicated by the detection of a corresponding PDCCH in subframe , where  on the primary cell, or for a PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  on the primary cell, the PUCCH resource is , where  is selected from {0, 1, 2, 3} such that ,  where  is determined from the primary cell, and for a subframe *n* with  and a transmission mode that supports up to two transport blocks on the serving cell where the corresponding PDSCH transmission occurs, the PUCCH resource  is given by  where  is the number of the first CCE used for transmission of the corresponding DCI assignment and  is configured by higher layers.

- for a PDSCH transmission on the primary cell where there is not a corresponding PDCCH/EPDCCH detected within subframe(s) , where , the value of  is determined according to higher layer configuration and Table 9.2-2.

- For a PDSCH transmission indicated by the detection of corresponding EPDCCH or a EPDCCH indicating downlink SPS release in sub-frame  where on the primary cell, the PUCCH resource  is given by

- if EPDCCH-PRB-set is configured for distributed transmission



- if EPDCCH-PRB-set is configured for localized transmission



where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter *pucch-ResourceStartOffset-r11 ,* for EPDCCH-PRB-set in subframe is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3]. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.2.1-1. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.3.1-2. If the UE is configured to monitor EPDCCH in subframe ,  is equal to the number of ECCEs in EPDCCH-PRB-set configured for that UE in subframe . If the UE is not configured to monitor EPDCCH in subframe ,  is equal to the number of ECCEs computed assuming EPDCCH-PRB-set is configured for that UE in subframe . For normal downlink CP, if subframe  is a special subframe with special subframe configuration 0, 5 or 10 if configured by *ssp10-CRS-LessDwPTS*, is equal to 0. For extended downlink CP, if subframe  is a special subframe with special subframe configuration 0 or 4 or 7, is equal to 0. For a subframe *n* with  and a transmission mode that supports up to two transport blocks on the serving cell where the corresponding PDSCH transmission occurs, the PUCCH resource  is given by

- if EPDCCH-PRB-set is configured for distributed transmission



- if EPDCCH-PRB-set is configured for localized transmission



- for a PDSCH transmission indicated by the detection of a corresponding PDCCH/EPDCCH within subframe(s) , where  on the secondary cell, the value of , and the value of  for a subframe *n* with  or for a subframe *n* with  and a transmission mode on the secondary cell that supports up to two transport blocks is determined according to higher layer configuration and Table 10.1.2.2.1-2. The TPC field in the DCI format of the corresponding PDCCH/EPDCCH shall be used to determine the PUCCH resource values from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.1-2. For a UE configured for a transmission mode on the secondary cell that supports up to two transport blocks and a subframe *n* with , or for a subframe *n* with , a PUCCH resource value in Table 10.1.2.2.1-2 maps to two PUCCH resources , otherwise, the PUCCH resource value maps to a single PUCCH resource . A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted in the TPC field on all PDCCH/EPDCCH assignments on the secondary cell within subframe(s) , where .

Table 10.1.3.2-1: Transmission of HARQ-ACK multiplexing for *A* = 2

|  |  |  |
| --- | --- | --- |
| HARQ-ACK(0), HARQ-ACK(1) |  |  |
| ACK, ACK |  | 1, 0 |
| ACK, NACK/DTX |  | 1, 1 |
| NACK/DTX, ACK |  | 0, 1 |
| NACK, NACK/DTX |  | 0, 0 |
| DTX, NACK/DTX | No Transmission | |

Table 10.1.3.2-2: Transmission of HARQ-ACK multiplexing for *A* = 3

|  |  |  |
| --- | --- | --- |
| HARQ-ACK(0), HARQ-ACK(1), HARQ-ACK(2) |  |  |
| ACK, ACK, ACK |  | 1, 1 |
| ACK, ACK, NACK/DTX |  | 1, 0 |
| ACK, NACK/DTX, ACK |  | 1, 0 |
| ACK, NACK/DTX, NACK/DTX |  | 1, 1 |
| NACK/DTX, ACK, ACK |  | 0, 1 |
| NACK/DTX, ACK, NACK/DTX |  | 0, 1 |
| NACK/DTX, NACK/DTX, ACK |  | 0, 0 |
| NACK, NACK/DTX, NACK/DTX |  | 0, 0 |
| DTX, NACK/DTX, NACK/DTX | No Transmission | |

Table 10.1.3.2-3: Transmission of HARQ-ACK multiplexing for *A* = 4

|  |  |  |
| --- | --- | --- |
| HARQ-ACK(0), HARQ-ACK(1), HARQ-ACK(2), HARQ-ACK(3) |  |  |
| ACK, ACK, ACK, ACK |  | 1, 1 |
| ACK, ACK, ACK, NACK/DTX |  | 1, 1 |
| ACK, ACK, NACK/DTX, ACK |  | 1, 0 |
| ACK, ACK, NACK/DTX, NACK/DTX |  | 1, 0 |
| ACK, NACK/DTX, ACK, ACK |  | 1, 1 |
| ACK, NACK/DTX, ACK, NACK/DTX |  | 1, 0 |
| ACK, NACK/DTX, NACK/DTX, ACK |  | 0, 1 |
| ACK, NACK/DTX, NACK/DTX, NACK/DTX |  | 1, 1 |
| NACK/DTX, ACK, ACK, ACK |  | 0, 0 |
| NACK/DTX, ACK, ACK, NACK/DTX |  | 0, 1 |
| NACK/DTX, ACK, NACK/DTX, ACK |  | 1, 0 |
| NACK/DTX, ACK, NACK/DTX, NACK/DTX |  | 0, 1 |
| NACK/DTX, NACK/DTX, ACK, ACK |  | 0, 1 |
| NACK/DTX, NACK/DTX, ACK, NACK/DTX |  | 0, 0 |
| NACK/DTX, NACK/DTX, NACK/DTX, ACK |  | 0, 0 |
| NACK, NACK/DTX, NACK/DTX, NACK/DTX |  | 0, 0 |
| DTX, NACK/DTX, NACK/DTX, NACK/DTX | No Transmission | |

Table 10.1.3.2-4: Mapping of subframes on each serving cell to HARQ-ACK(*j*) for PUCCH format 1b HARQ-ACK channel selection for TDD with 

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| A | HARQ-ACK(j) | | | |
| HARQ-ACK(0) | HARQ-ACK(1) | HARQ-ACK(2) | HARQ-ACK(3) |
| 4 | The first subframe  of Primary cell | The second subframe  of Primary cell | The first subframe  of Secondary cell | The second subframe  of Secondary cell |

For TDD HARQ-ACK multiplexing with PUCCH format 1b with channel selection and sub-frame  with  and two configured serving cells, denotes  as the PUCCH resource derived from the transmissions in  downlink or special sub-frames associated with the UL subframe *n* .  and are associated with the PDSCH transmission(s) or a PDCCH/EPDCCH indicating downlink SPS release (defined in Clause 9.2) on the primary cell and  and are associated with the PDSCH transmission(s) on the secondary cell.

For Primary cell:

- If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, and if there is a PDSCH transmission on the primary cell without a corresponding PDCCH/EPDCCH detected within the subframe(s) , where ,

- the value of  is determined according to higher layer configuration and Table 9.2-2.

- for a PDSCH transmission on the primary cell indicated by the detection of a corresponding PDCCH in subframe , where  with the DAI value in the PDCCH equal to '1' (defined in Table 7.3-X) or a PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  with the DAI value in the PDCCH equal to '1', the PUCCH resource  where  is selected from {0, 1, 2, 3} such that , , where  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe  and  is configured by higher layers.

- for a PDSCH transmission on the primary cell indicated by the detection of a corresponding EPDCCH in subframe , where  with the DAI value in the EPDCCH equal to '1' (defined in Table 7.3-X) or an EPDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  with the DAI value in the EPDCCH equal to '1', the PUCCH resource is given by

- If EPDCCH-PRB-set is configured for distributed transmission



- If EPDCCH-PRB-set is configured for localized transmission



where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter *pucch-ResourceStartOffset-r11 ,* for EPDCCH-PRB-set in subframe is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3]. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.2.1-1. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.3.1-2. If the UE is configured to monitor EPDCCH in subframe ,  is equal to the number of ECCEs in EPDCCH-PRB-set configured for that UE in subframe . If the UE is not configured to monitor EPDCCH in subframe ,  is equal to the number of ECCEs computed assuming EPDCCH-PRB-set is configured for that UE in subframe. For normal downlink CP, if subframe  is a special subframe with special subframe configuration 0, 5 or 10 if configured by *ssp10-CRS-LessDwPTS*, is equal to 0. For extended downlink CP, if subframe  is a special subframe with special subframe configuration 0 or 4 or 7, is equal to 0.

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, and if there is a PDSCH transmission on the primary cell without a corresponding PDCCH/EPDCCH detected within the subframe(s) , where ,

- the value of  is determined according to higher layer configuration and Table 9.2-2.

- for a PDSCH transmission on the primary cell indicated by the detection of a corresponding PDCCH in subframe , where  with the DAI value in the PDCCH equal to '1' (defined in Table 7.3-X) or a PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  with the DAI value in the PDCCH equal to '1',

- if the value of is same as the value of an element , where , the PUCCH resource  is given by ;

- otherwise, if the value of  is same as the value of an element  in set , where (defined in Table 10.1.3.1-1A), the PUCCH resource  is given by ;

where  is the number of elements in the set  defined in Table 10.1.3.1-1A , where  is selected from {0, 1, 2, 3} such that ,  where  is determined from the primary cell,  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe , and , , are configured by higher layers .

- for a PDSCH transmission on the primary cell indicated by the detection of a corresponding EPDCCH in subframe, where  with the DAI value in the EPDCCH equal to '1' (defined in Table 7.3-X) or an EPDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  with the DAI value in the EPDCCH equal to '1', the PUCCH resource is given by

- If EPDCCH-PRB-set is configured for distributed transmission



- If EPDCCH-PRB-set is configured for localized transmission



where

- if the value of  is same as the value of an index , where , then and ;

- otherwise, if the value of is same as the value of an index , where , then and ;

, and where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter *pucch-ResourceStartOffset-r11 ,* for EPDCCH-PRB-set in subframe is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3]. , ,  are determined as described in Clause 10.1.3.1.

- HARQ-ACK(0) is the ACK/NACK/DTX response for the PDSCH transmission without a corresponding PDCCH/EPDCCH. For , if a PDSCH transmission with a corresponding PDCCH/EPDCCH and DAI value in the PDCCH/EPDCCH equal to '' or a PDCCH/EPDCCH indicating downlink SPS release and with DAI value in the PDCCH/EPDCCH equal to '' is received, HARQ-ACK(j) is the corresponding ACK/NACK/DTX response; otherwise HARQ-ACK(j) shall be set to DTX.

- Otherwise,

- If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, for a PDSCH transmission on the primary cell indicated by the detection of a corresponding PDCCH in subframe , where  and for TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,6} the DAI value in the PDCCH equal to either '1' or '2' or a PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  and for TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,6} the DAI value in the PDCCH equal to either '1' or '2', the PUCCH resource , where  is selected from {0, 1, 2, 3} such that , , where  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe ,  is configured by higher layers and for TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,6},  for the corresponding PDCCH with the DAI value equal to '1' and  for the corresponding PDCCH with the DAI value equal to '2', and for the primary cell with TDD UL/DL configuration 0  for the corresponding PDCCH.

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, for a PDSCH transmission on the primary cell indicated by the detection of a corresponding PDCCH in subframe , where  and for TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,6} the DAI value in the PDCCH equal to either '1' or '2' or a PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  and for TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,6} the DAI value in the PDCCH equal to either '1' or '2',

- if the value of is same as the value of an element , where , the PUCCH resource  is given by ;

- otherwise, if the value of is same as the value of an element  in set , where (defined in Table 10.1.3.1-1A), the PUCCH resource  is given by ;

where  is the number of elements in the set , where  is selected from {0, 1, 2, 3} such that ,  where  is determined from the primary cell,  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe , and , , are configured by higher layers. Here, for TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,6},  for the corresponding PDCCH with the DAI value equal to '1' and  for the corresponding PDCCH with the DAI value equal to '2', and for the primary cell with TDD UL/DL configuration 0  for the corresponding PDCCH.

- If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell for a PDSCH transmission on the primary cell indicated by the detection of a corresponding EPDCCH in subframe , where  and for TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,6} the DAI value in the EPDCCH equal to either '1' or '2' or an EPDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  and for TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,6}the DAI value in the EPDCCH equal to either '1' or '2', the PUCCH resource is given by

- If EPDCCH-PRB-set is configured for distributed transmission



- If EPDCCH-PRB-set is configured for localized transmission



where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter *pucch-ResourceStartOffset-r11 ,* for EPDCCH-PRB-set in subframe is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3]. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.2.1-1. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.3.1-2. If the UE is configured to monitor EPDCCH in subframe ,  is equal to the number of ECCEs in EPDCCH-PRB-set configured for that UE in subframe . If the UE is not configured to monitor EPDCCH in subframe,  is equal to the number of ECCEs computed assuming EPDCCH-PRB-set is configured for that UE in subframe . For normal downlink CP, if subframe  is a special subframe with special subframe configuration 0, 5 or 10 if configured by *ssp10-CRS-LessDwPTS*, is equal to 0. For extended downlink CP, if subframe  is a special subframe with special subframe configuration 0 or 4 or 7, is equal to 0. Here, for TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,6}  for the corresponding EPDCCH with the DAI value equal to '1' and  for the corresponding EPDCCH with the DAI value equal to '2', and for the primary cell with TDD UL/DL configuration 0 for the corresponding EPDCCH.

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell for a PDSCH transmission on the primary cell indicated by the detection of a corresponding EPDCCH in subframe , where  and for TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,6} the DAI value in the EPDCCH equal to either '1' or '2' or an EPDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe, where  and for TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,6}the DAI value in the EPDCCH equal to either '1' or '2', the PUCCH resource is given by

- If EPDCCH-PRB-set is configured for distributed transmission



- If EPDCCH-PRB-set is configured for localized transmission



where

- if the value of  is same as the value of an index , where , then ;

- otherwise, if the value of  is same as the value of an index , where , then ;

, and where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter *pucch-ResourceStartOffset-r11 ,* for EPDCCH-PRB-set in subframe  is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3].. , , are determined as described in Clause 10.1.3.1. Here, for TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,6}  for the corresponding EPDCCH with the DAI value equal to '1' and  for the corresponding EPDCCH with the DAI value equal to '2', and for the primary cell with TDD UL/DL configuration 0 for the corresponding EPDCCH.

- For  and TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,6}, if a PDSCH transmission with a corresponding PDCCH/EPDCCH and DAI value in the PDCCH/EPDCCH equal to '' or a PDCCH/EPDCCH indicating downlink SPS release and with DAI value in the PDCCH/EPDCCH equal to '' is received, HARQ-ACK(j) is the corresponding ACK/NACK/DTX response; otherwise HARQ-ACK(j) shall be set to DTX. For  and the primary cell with TDD UL/DL configuration 0, if a PDSCH transmission with a corresponding PDCCH/EPDCCH or a PDCCH/EPDCCH indicating downlink SPS release is received, HARQ-ACK(0) is the corresponding ACK/NACK/DTX response; otherwise HARQ-ACK(j) shall be set to DTX.

For Secondary cell:

- If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, for a PDSCH transmission on the secondary cell indicated by the detection of a corresponding PDCCH on the primary cell in subframe , where  with the DAI value in the PDCCH equal to either '1' or '2', the PUCCH resources , where  is selected from {0, 1, 2, 3} such that , , where  is determined from the primary cell,  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe ,  is configured by higher layers,  for the corresponding PDCCH with the DAI value equal to '1' and  for the corresponding PDCCH with the DAI value equal to '2'.

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, for a PDSCH transmission on the secondary cell indicated by the detection of a corresponding PDCCH on the primary cell in subframe , where  with the DAI value in the PDCCH equal to either '1' or '2',

- if the value of is same as the value of an element , where , the PUCCH resource  is given by ;

- otherwise, if the value of is same as the value of an element  in set , where (defined in Table 10.1.3.1-1A, where "UL/DL configuration" in the table refers to the higher layer parameter *subframeAssignment*), the PUCCH resource  is given by ;

where  is the number of elements in the set  defined in Table 10.1.3.1-1A , where  is selected from {0, 1, 2, 3} such that ,  where  is determined from the primary cell,  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe , and , , are configured by higher layers. Here,  for the corresponding PDCCH with the DAI value equal to '1' and  for the corresponding PDCCH the DAI value in the PDCCH equal to either '1' or '2'.

- If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, for a PDSCH transmission on the secondary cell indicated by the detection of a corresponding EPDCCH on the primary cell in subframe , where  with the DAI value in the PDCCH equal to either '1' or '2', the PUCCH resources are given by

- If EPDCCH-PRB-set is configured for distributed transmission



- If EPDCCH-PRB-set is configured for localized transmission



where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter *pucch-ResourceStartOffset-r11 ,* for EPDCCH-PRB-set in subframe is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3]. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.2.1-1. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.3.1-2. If the UE is configured to monitor EPDCCH in subframe ,  is equal to the number of ECCEs in EPDCCH-PRB-set configured for that UE in subframe . If the UE is not configured to monitor EPDCCH in subframe,  is equal to the number of ECCEs computed assuming EPDCCH-PRB-set is configured for that UE in subframe. For normal downlink CP, if subframe  is a special subframe with special subframe configuration 0, 5 or 10 if configured by *ssp10-CRS-LessDwPTS*, is equal to 0. For extended downlink CP, if subframe  is a special subframe with special subframe configuration 0 or 4 or 7, is equal to 0. Here,  for the corresponding EPDCCH with the DAI value equal to '1' and  for the corresponding EPDCCH with the DAI value equal to '2'.

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, for a PDSCH transmission on the secondary cell indicated by the detection of a corresponding EPDCCH on the primary cell in subframe , where  with the DAI value in the PDCCH equal to either '1' or '2', the PUCCH resources are given by

- If EPDCCH-PRB-set is configured for distributed transmission



- If EPDCCH-PRB-set is configured for localized transmission



where

- if the value of  is same as the value of an index , where , then ;

- otherwise, if the value of  is same as the value of an index , where , then ;

and where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter *pucch-ResourceStartOffset-r11 ,* for EPDCCH-PRB-set in subframe  is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3]. , , are determined as described in Clause 10.1.3.1. For extended downlink CP, if subframe  is a special subframe with special subframe configuration 0 or 4 or 7,  is equal to 0. Here,  for the corresponding EPDCCH with the DAI value equal to '1' and  for the corresponding EPDCCH with the DAI value equal to '2'.

- for a PDSCH transmission indicated by the detection of a corresponding PDCCH/EPDCCH within the subframe(s) , where  on the secondary cell, the value of and  is determined according to higher layer configuration and Table 10.1.2.2.1-2. The TPC field in the DCI format of the corresponding PDCCH/EPDCCH shall be used to determine the PUCCH resource values from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.1-2. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted in the TPC field on all PDCCH/EPDCCH assignments on the secondary cell within subframe(s) , where .

- For , if a PDSCH transmission with a corresponding PDCCH/EPDCCH and DAI value in the PDCCH/EPDCCH equal to '' is received, HARQ-ACK(j) is the corresponding ACK/NACK/DTX response; otherwise HARQ-ACK(j) shall be set to DTX.

A UE shall perform channel selection according to the Tables 10.1.3.2-5, and 10.1.3.2-6 and transmit  on PUCCH resource  for  mapped to antenna port *p* using PUCCH format 1b according to Clause 5.4.1 in [3] where

-  =  in sub-frame  for  mapped to antenna port  where "any" in Tables 10.1.3.2-5, and 10.1.3.2-6 represents any response of ACK, NACK, or DTX. The value of  and the PUCCH resource  are generated by channel selection according to Tables 10.1.3.2-5, and 10.1.3.2-6 for *M* = 3, and 4 respectively.

-  for antenna port, where  selected from PUCCH resources, configured by higher layers where  according Tables 10.1.3.2-5, and 10.1.3.2-6 for *M* = 3, and 4 respectively by replacing with and replacing  with , where "any" in Tables 10.1.3.2-5, and 10.1.3.2-6 represents any response of ACK, NACK, or DTX, when the UE is configured with two antenna port transmission for PUCCH format 1b with channel selection.

Table 10.1.3.2-5: Transmission of HARQ-ACK multiplexing for *M* = 3

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Primary Cell | Secondary Cell | Resource | Constellation | RM Code  Input Bits |
| HARQ-ACK(0),  HARQ-ACK(1),  HARQ-ACK(2) | HARQ-ACK(0),  HARQ-ACK(1),  HARQ-ACK(2) |  |  |  |
| ACK, ACK, ACK | ACK, ACK, ACK |  | 1, 1 | 1,1,1,1 |
| ACK, ACK, NACK/DTX | ACK, ACK, ACK |  | 0, 0 | 1,0,1,1 |
| ACK, NACK/DTX, any | ACK, ACK, ACK |  | 1, 1 | 0,1,1,1 |
| NACK/DTX, any, any | ACK, ACK, ACK |  | 0, 1 | 0,0,1,1 |
| ACK, ACK, ACK | ACK, ACK, NACK/DTX |  | 1, 0 | 1,1,1,0 |
| ACK, ACK, NACK/DTX | ACK, ACK, NACK/DTX |  | 1, 0 | 1,0,1,0 |
| ACK, NACK/DTX, any | ACK, ACK, NACK/DTX |  | 0, 1 | 0,1,1,0 |
| NACK/DTX, any, any | ACK, ACK, NACK/DTX |  | 0, 0 | 0,0,1,0 |
| ACK, ACK, ACK | ACK, NACK/DTX, any |  | 1, 1 | 1, 1, 0, 1 |
| ACK, ACK, NACK/DTX | ACK, NACK/DTX, any |  | 0, 1 | 1, 0, 0, 1 |
| ACK, NACK/DTX, any | ACK, NACK/DTX, any |  | 1, 0 | 0, 1, 0, 1 |
| NACK/DTX, any, any | ACK, NACK/DTX, any |  | 0, 0 | 0, 0, 0, 1 |
| ACK, ACK, ACK | NACK/DTX, any, any |  | 1, 0 | 1, 1, 0, 0 |
| ACK, ACK, NACK/DTX | NACK/DTX, any, any |  | 0, 1 | 1, 0, 0, 0 |
| ACK, NACK/DTX, any | NACK/DTX, any, any |  | 1, 1 | 0, 1, 0, 0 |
| NACK, any, any | NACK/DTX, any, any |  | 0, 0 | 0, 0, 0, 0 |
| DTX, any, any | NACK/DTX, any, any | No Transmission | | 0, 0, 0, 0 |

Table 10.1.3.2-6: Transmission of HARQ-ACK multiplexing for *M* = 4

| Primary Cell | Secondary Cell | Resource | Constellation | RM Code  Input Bits |
| --- | --- | --- | --- | --- |
| HARQ-ACK(0),  HARQ-ACK(1),  HARQ-ACK(2),  HARQ-ACK(3) | HARQ-ACK(0),  HARQ-ACK(1),  HARQ-ACK(2),  HARQ-ACK(3) |  |  |  |
| ACK, ACK, ACK, NACK/DTX | ACK, ACK, ACK, NACK/DTX |  | 1, 1 | 1, 1, 1, 1 |
| ACK, ACK, NACK/DTX, any | ACK, ACK, ACK, NACK/DTX |  | 0, 0 | 1, 0, 1, 1 |
| ACK, DTX, DTX, DTX | ACK, ACK, ACK, NACK/DTX |  | 1, 1 | 0, 1, 1, 1 |
| ACK, ACK, ACK, ACK | ACK, ACK, ACK, NACK/DTX |  | 1, 1 | 0, 1, 1, 1 |
| NACK/DTX, any, any, any | ACK, ACK, ACK, NACK/DTX |  | 0, 1 | 0, 0, 1, 1 |
| (ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX) | ACK, ACK, ACK, NACK/DTX |  | 0, 1 | 0, 0, 1, 1 |
| ACK, ACK, ACK, NACK/DTX | ACK, ACK, NACK/DTX, any |  | 1, 0 | 1, 1, 1, 0 |
| ACK, ACK, NACK/DTX, any | ACK, ACK, NACK/DTX, any |  | 1, 0 | 1, 0, 1, 0 |
| ACK, DTX, DTX, DTX | ACK, ACK, NACK/DTX, any |  | 0, 1 | 0, 1, 1, 0 |
| ACK, ACK, ACK, ACK | ACK, ACK, NACK/DTX, any |  | 0, 1 | 0, 1, 1, 0 |
| NACK/DTX, any, any, any | ACK, ACK, NACK/DTX, any |  | 0, 0 | 0, 0, 1, 0 |
| (ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX) | ACK, ACK, NACK/DTX, any |  | 0, 0 | 0, 0, 1, 0 |
| ACK, ACK, ACK, NACK/DTX | ACK, DTX, DTX, DTX |  | 1, 1 | 1, 1, 0, 1 |
| ACK, ACK, ACK, NACK/DTX | ACK, ACK, ACK, ACK |  | 1, 1 | 1, 1, 0, 1 |
| ACK, ACK, NACK/DTX, any | ACK, DTX, DTX, DTX |  | 0, 1 | 1, 0, 0, 1 |
| ACK, ACK, NACK/DTX, any | ACK, ACK, ACK, ACK |  | 0, 1 | 1, 0, 0, 1 |
| ACK, DTX, DTX, DTX | ACK, DTX, DTX, DTX |  | 1, 0 | 0, 1, 0, 1 |
| ACK, DTX, DTX, DTX | ACK, ACK, ACK, ACK |  | 1, 0 | 0, 1, 0, 1 |
| ACK, ACK, ACK, ACK | ACK, DTX, DTX, DTX |  | 1, 0 | 0, 1, 0, 1 |
| ACK, ACK, ACK, ACK | ACK, ACK, ACK, ACK |  | 1, 0 | 0, 1, 0, 1 |
| NACK/DTX, any, any, any | ACK, DTX, DTX, DTX |  | 0, 0 | 0, 0, 0, 1 |
| NACK/DTX, any, any, any | ACK, ACK, ACK, ACK |  | 0, 0 | 0, 0, 0, 1 |
| (ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX) | ACK, DTX, DTX, DTX |  | 0, 0 | 0, 0, 0, 1 |
| (ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX) | ACK, ACK, ACK, ACK |  | 0, 0 | 0, 0, 0, 1 |
| ACK, ACK, ACK, NACK/DTX | NACK/DTX, any, any, any |  | 1, 0 | 1, 1, 0, 0 |
| ACK, ACK, ACK, NACK/DTX | (ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX) |  | 1, 0 | 1, 1, 0, 0 |
| ACK, ACK, NACK/DTX, any | NACK/DTX, any, any, any |  | 0, 1 | 1, 0, 0, 0 |
| ACK, ACK, NACK/DTX, any | (ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX) |  | 0, 1 | 1, 0, 0, 0 |
| ACK, DTX, DTX, DTX | NACK/DTX, any, any, any |  | 1, 1 | 0, 1, 0, 0 |
| ACK, DTX, DTX, DTX | (ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX) |  | 1, 1 | 0, 1, 0, 0 |
| ACK, ACK, ACK, ACK | NACK/DTX, any, any, any |  | 1, 1 | 0, 1, 0, 0 |
| ACK, ACK, ACK, ACK | (ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX) |  | 1, 1 | 0, 1, 0, 0 |
| NACK, any, any, any | NACK/DTX, any, any, any |  | 0, 0 | 0, 0, 0, 0 |
| NACK, any, any, any | (ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX) |  | 0, 0 | 0, 0, 0, 0 |
| (ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX) | NACK/DTX, any, any, any |  | 0, 0 | 0, 0, 0, 0 |
| (ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX) | (ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX) |  | 0, 0 | 0, 0, 0, 0 |
| DTX, any, any, any | NACK/DTX, any, any, any | No Transmission | | 0, 0, 0, 0 |
| DTX, any, any, any | (ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX) | No Transmission | | 0, 0, 0, 0 |

##### 10.1.3.2.2 PUCCH format 3 HARQ-ACK procedure

If a UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12*, then where the set  is defined in Table 10.1.3.1-1 (where "UL/DL configuration" in the table refers to the higher layer parameter *subframeAssignment*), and is the number of elements in set .

If a UE is configured with one serving cell, or if a UE is configured with more than one serving cells and the UL/DL configuration of all serving cells is same, then in the rest of this Clause  is as defined in Sec 10.2, and  is the number of elements in the set .

If a UE is configured with more than one serving cell and if at least two cells have different UL/DL configurations, then in this Clause refers to  (as defined in Clause 10.2) , and  is the number of elements in the set .

For TDD HARQ-ACK transmission with PUCCH format 3 and sub-frame  with  and more than one configured serving cell, where  is the number of elements in the set , the UE shall use PUCCH resource  or  for transmission of HARQ-ACK in subframe  for  mapped to antenna port *p* where

- If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell,

- for a single PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe , where , and for a TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} the DAI value in the PDCCH is equal to '1' (defined in Table 7.3-X), or

- for a single PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where , and for a TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} the DAI value in the PDCCH is equal to '1',

- the UE shall use PUCCH format 1a/1b and PUCCH resource  with  for antenna port , where  is configured by higher layers,  is selected from {0, 1, 2, 3} such that , , and  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe  where . When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port  is given by 

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell,

- for a single PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe , where , and for a TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} the DAI value in the PDCCH is equal to '1' (defined in Table 7.3-X), or

- for a single PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where , and for a TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} the DAI value in the PDCCH is equal to '1',

- the UE shall use PUCCH format 1a/1b, and

- if the value of is same as the value of an element , where , the PUCCH resource  is given by ;

- otherwise, if the value of is same as the value of an element  in set , where (defined in Table 10.1.3.1-1A, where "UL/DL configuration" in the table refers to the higher layer parameter *subframeAssignment*), the PUCCH resource  is given by ;

where  is the number of elements in the set  defined in Table 10.1.3.1-1A , where  is selected from {0, 1, 2, 3} such that ,  where  is determined from the primary cell,  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe , and , , are configured by higher layers. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port  is given by 

- If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell,

- for a single PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe , where , and for a TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} the DAI value in the EPDCCH is equal to '1' (defined in Table 7.3-X), or

- for a single PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where , and for a TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} the DAI value in the EPDCCH is equal to '1',

- the UE shall use PUCCH format 1a/1b and PUCCH resource  given by

- If EPDCCH-PRB-set is configured for distributed transmission



- If EPDCCH-PRB-set is configured for localized transmission



where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter pucch-ResourceStartOffset-r11 , for EPDCCH-PRB-set in subframe is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3]. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.2.1-1. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.3.1-2. If the UE is configured to monitor EPDCCH in subframe ,  is equal to the number of ECCEs in EPDCCH-PRB-set configured for that UE in subframe . If the UE is not configured to monitor EPDCCH in subframe,  is equal to the number of ECCEs computed assuming EPDCCH-PRB-set is configured for that UE in subframe . For normal downlink CP, if subframe  is a special subframe with special subframe configuration 0, 5 or 10 if configured by *ssp10-CRS-LessDwPTS*, is equal to 0. For extended downlink CP, if subframe  is a special subframe with special subframe configuration 0 or 4 or 7, is equal to 0. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port  is given by .

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell,

- for a single PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe , where , and for a TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} the DAI value in the EPDCCH is equal to '1' (defined in Table 7.3-X), or

- for a single PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where , and for a TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} the DAI value in the EPDCCH is equal to '1',

- the UE shall use PUCCH format 1a/1b and PUCCH resource  given by

- if EPDCCH-PRB-set is configured for distributed transmission



- if EPDCCH-PRB-set is configured for localized transmission



where

- if the value of  is same as the value of an index , where , then ;

- otherwise, if the value of  is same as the value of an index , where , then ;

and where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter *pucch-ResourceStartOffset-r11 ,* for EPDCCH-PRB-set in subframe  is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3]. , , are determined as described in Clause 10.1.3.1. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port  is given by .

- for a single PDSCH transmission only on the primary cell where there is not a corresponding PDCCH/EPDCCH detected within subframe(s) , where  and no PDCCH/EPDCCH indicating downlink SPS release (defined in Clause 9.2) within subframe(s) , where , the UE shall use PUCCH format 1a/1b and PUCCH resource  with the value of  is determined according to higher layer configuration and Table 9.2-2. For a UE configured for two antenna port transmission for PUCCH format 1a/1b, a PUCCH resource value in Table 9.2-2 maps to two PUCCH resources with the first PUCCH resource  for antenna port  and the second PUCCH resource  for antenna port , otherwise, the PUCCH resource value maps to a single PUCCH resource  for antenna port .

- for , and

- for a PDSCH transmission only on the primary cell where there is not a corresponding PDCCH detected within subframe(s) , where , and

- for an additional PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe , where  with the DAI value in the PDCCH equal to '1' (defined in Table 7.3-X), or

- for an additional PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  with the DAI value in the PDCCH equal to '1',

- the UE shall transmit  in subframe  using PUCCH format 1b on PUCCH resource  selected from  PUCCH resources  where , according to Table 10.1.3.2-1 and Table 10.1.3.2-2 for  and , respectively. For a UE configured with a transmission mode that supports up to two transport blocks on the primary cell, ; otherwise, .

- If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource  is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource  is determined as , where  is configured by higher layers,  is selected from {0, 1, 2, 3} such that , , and  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe  where .

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource  is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource  is determined as

- if the value of is same as the value of an element , where , the PUCCH resource is given by ;

- otherwise, if the value of is same as the value of an element  in set , where (defined in Table 10.1.3.1-1A, where "UL/DL configuration" in the table refers to the higher layer parameter *subframeAssignment*), the PUCCH resource  is given by ;

where  is the number of elements in the set  defined in Table 10.1.3.1-1A , where  is selected from {0, 1, 2, 3} such that , ,  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe , and , , are configured by higher layers.

- For a UE configured with a transmission mode that supports up to two transport blocks on the primary cell, the PUCCH resource  is determined as .HARQ-ACK(0) is the ACK/NACK/DTX response for the PDSCH without a corresponding PDCCH detected. HARQ-ACK(1) is the ACK/NACK/DTX response for the first transport block of the PDSCH indicated by the detection of a corresponding PDCCH for which the value of the DAI field in the corresponding DCI format is equal to '1' or for the PDCCH indicating downlink SPS release for which the value of the DAI field in the corresponding DCI format is equal to '1'. HARQ-ACK(2) is the ACK/NACK/DTX response for the second transport block of the PDSCH indicated by the detection of a corresponding PDCCH for which the value of the DAI field in the corresponding DCI format is equal to '1'.

- for , and

- for a PDSCH transmission only on the primary cell where there is not a corresponding EPDCCH detected within subframe(s) , where  , and

- for an additional PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe , where  with the DAI value in the EPDCCH equal to '1' (defined in Table 7.3-X), or

- for an additional EPDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  with the DAI value in the EPDCCH equal to '1',

- the UE shall transmit  in subframe  using PUCCH format 1b on PUCCH resource  selected from  PUCCH resources  where , according to Table 10.1.3.2-1 and Table 10.1.3.2-2 for  and , respectively. For a UE configured with a transmission mode that supports up to two transport blocks on the primary cell, ; otherwise, .

- If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource  is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource  is determined as

- If EPDCCH-PRB-set is configured for distributed transmission



- If EPDCCH-PRB-set is configured for localized transmission



where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter pucch-ResourceStartOffset-r11 , for EPDCCH-PRB-set in subframe is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3]. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.2.1-1. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.3.1-2. If the UE is configured to monitor EPDCCH in subframe ,  is equal to the number of ECCEs in EPDCCH-PRB-set configured for that UE in subframe . If the UE is not configured to monitor EPDCCH in subframe,  is equal to the number of ECCEs computed assuming EPDCCH-PRB-set is configured for that UE in subframe. For normal downlink CP, if subframe  is a special subframe with special subframe configuration 0, 5 or 10 if configured by *ssp10-CRS-LessDwPTS*, is equal to 0. For extended downlink CP, if subframe  is a special subframe with special subframe configuration 0 or 4 or 7, is equal to 0.

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource  is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource  is determined as

- If EPDCCH-PRB-set is configured for distributed transmission



- If EPDCCH-PRB-set is configured for localized transmission



where

- if the value of  is same as the value of an index , where , then ;

- otherwise, if the value of  is same as the value of an index , where , then ;

- and where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter *pucch-ResourceStartOffset-r11 ,* for EPDCCH-PRB-set in subframe  is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3]. , , are determined as described in Clause 10.1.3.1.

- For a UE configured with a transmission mode that supports up to two transport blocks on the primary cell, the PUCCH resource  is determined as .HARQ-ACK(0) is the ACK/NACK/DTX response for the PDSCH without a corresponding EPDCCH detected. HARQ-ACK(1) is the ACK/NACK/DTX response for the first transport block of the PDSCH indicated by the detection of a corresponding EPDCCH for which the value of the DAI field in the corresponding DCI format is equal to '1' or for the EPDCCH indicating downlink SPS release for which the value of the DAI field in the corresponding DCI format is equal to '1'. HARQ-ACK(2) is the ACK/NACK/DTX response for the second transport block of the PDSCH indicated by the detection of a corresponding EPDCCH for which the value of the DAI field in the corresponding DCI format is equal to '1'.

- for , and

- for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe , where  with the DAI value in the PDCCH greater than '1' (defined in Table 7.3-X), or

- for a PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  with the DAI value in the PDCCH greater than '1', or

- for  and for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe , where  with the DAI value in the PDCCH equal to '1' (defined in Table 7.3-X) not being the first PDCCH/EPDCCH transmission in subframe(s) , where  with the DAI value equal to '1', or

- for  and for a PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  with the DAI value in the PDCCH equal to '1' (defined in Table 7.3-X) not being the first PDCCH/EPDCCH transmission in subframe(s) , where  with the DAI value equal to '1',

- the UE shall use PUCCH format 3 and PUCCH resource  where the value of  is determined according to higher layer configuration and Table 10.1.2.2.2-1 and the TPC field in a PDCCH assignment with DAI value greater than '1' (defined in Table 7.3-X) or with DAI value equal to '1', not being the first PDCCH/EPDCCH assignment in subframe(s) , where  with the DAI value equal to '1', shall be used to determine the PUCCH resource value from one of the four PUCCH resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.2-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted on all PDCCH assignments used to determine the PUCCH resource values within the subframe(s) , where .

- for , and

- for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe , where  with the DAI value in the EPDCCH greater than '1' (defined in Table 7.3-X), or

- for an EPDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  with the DAI value in the EPDCCH greater than '1', or

- for  and for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe , where  with the DAI value in the EPDCCH equal to '1' (defined in Table 7.3-X) not being the first PDCCH/EPDCCH transmission in subframe(s) , where  with the DAI value equal to '1', or

- for  and for an EPDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  with the DAI value in the EPDCCH equal to '1' (defined in Table 7.3-X) not being the first PDCCH/EPDCCH transmission in subframe(s) , where  with the DAI value equal to '1',

- the UE shall use PUCCH format 3 and PUCCH resource  where the value of  is determined according to higher layer configuration and Table 10.1.2.2.2-1 and the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH assignment with DAI value greater than '1' or with DAI value equal to '1' (defined in Table 7.3-X), not being the first PDCCH/EPDCCH assignment in subframe(s) , where  with the DAI value equal to '1', shall be used to determine the PUCCH resource value from one of the four PUCCH resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.2-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted on all EPDCCH assignments used to determine the PUCCH resource values within the subframe(s) , where .

- If the UL/DL configurations of all serving cells are the same, for a PDSCH transmission on the secondary cell indicated by the detection of a corresponding PDCCH/EPDCCH within subframe(s) , where , the UE shall use PUCCH format 3 and PUCCH resource  where the value of  is determined according to higher layer configuration and Table 10.1.2.2.2-1 and the TPC field in the corresponding PDCCH/EPDCCH shall be used to determine the PUCCH resource value from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.2-1. For TDD UL/DL configurations 1-6, if a PDCCH corresponding to a PDSCH on the primary cell within subframe(s) , where , or a PDCCH indicating downlink SPS release (defined in Clause 9.2) within subframe(s) , where , is detected, the TPC field in the PDCCH with the DAI value greater than '1' or with DAI value equal to '1', not being the first PDCCH/EPDCCH transmission in subframe(s) , where  with the DAI value equal to '1' (defined in Table 7.3-X), shall be used to determine the PUCCH resource value from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.2-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted on all PDCCH assignments in the primary cell and in each secondary cell that are used to determined the PUCCH resource value within the subframe(s) , where . For TDD UL/DL configurations 1-6, if an EPDCCH corresponding to a PDSCH on the primary cell within subframe(s) , where , or an EPDCCH indicating downlink SPS release (defined in Clause 9.2) within subframe(s) , where , is detected, the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH assignment with the DAI value greater than '1' (defined in Table 7.3-X) or with DAI value equal to '1', not being the first PDCCH/EPDCCH transmission in subframe(s) , where  with the DAI value equal to '1', shall be used to determine the PUCCH resource value from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.2-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted on all EPDCCH assignments in the primary cell and in each secondary cell that are used to determined the PUCCH resource value within the subframe(s) , where .

- If the UL/DL configurations of at least two serving cells are different, for a PDSCH transmission on the secondary cell indicated by the detection of a corresponding PDCCH/EPDCCH within subframe(s) , where , the UE shall use PUCCH format 3 and PUCCH resource  where the value of  is determined according to higher layer configuration and Table 10.1.2.2.2-1 and the TPC field in the corresponding PDCCH/EPDCCH shall be used to determine the PUCCH resource value from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.2-1. For a UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} as defined in Clause 10.2, if a PDCCH corresponding to a PDSCH on the primary cell within subframe(s) , where , or a PDCCH indicating downlink SPS release (defined in Clause 9.2) within subframe(s) , where , is detected, the TPC field in the PDCCH with the DAI value greater than '1' (defined in Table 7.3-X) or with DAI value equal to '1', not being the first PDCCH/EPDCCH transmission in subframe(s) , where  with the DAI value equal to '1', shall be used to determine the PUCCH resource value from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.2-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted on all PDCCH assignments in the primary cell and in each secondary cell that are used to determined the PUCCH resource value within the subframe(s) , where . For a UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} as defined in Clause 10.2, if an EPDCCH corresponding to a PDSCH on the primary cell within subframe(s) , where , or an EPDCCH indicating downlink SPS release (defined in Clause 9.2) within subframe(s) , where , is detected, the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH assignment with the DAI value greater than '1' or with DAI value equal to '1', not being the first PDCCH/EPDCCH transmission in subframe(s) , where  with the DAI value equal to '1', shall be used to determine the PUCCH resource value from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.2-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted on all EPDCCH assignments in the primary cell and in each secondary cell that are used to determined the PUCCH resource value within the subframe(s) , where .

- For PUCCH format 3 and PUCCH resource  and a UE configured for two antenna port transmission, a PUCCH resource value in Table 10.1.2.2.2-1 maps to two PUCCH resources with the first PUCCH resource  for antenna port  and the second PUCCH resource  for antenna port , otherwise, the PUCCH resource value maps to a single PUCCH resource  for antenna port .

##### 10.1.3.2.3 PUCCH format 4 HARQ-ACK procedure

TDD HARQ-ACK feedback procedures for a UE configured with PUCCH format 4 and *codebooksizeDetermination-r13 = cc* is described in Clause 10.1.3.2.3.1.

TDD HARQ-ACK feedback procedures for a UE configured with PUCCH format 4 and *codebooksizeDetermination-r13 = dai* is described in Clause 10.1.3.2.3.2.

10.1.3.2.3.1 PUCCH format 4 HARQ-ACK procedure without adaptive codebook

The procedure in this Clause applies to a UE configured with PUCCH format 4 and *codebooksizeDetermination-r13 = cc*.

If a UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12*, then where the set  is defined in Table 10.1.3.1-1 (where "UL/DL configuration" in the table refers to the higher layer parameter *subframeAssignment*), and is the number of elements in set .

If a UE is configured with more than one serving cells and the UL/DL configuration of all serving cells is same, then in the rest of this Clause  is as defined in Sec 10.2, and  is the number of elements in the set .

If a UE is configured with more than one serving cell and if at least two cells have different UL/DL configurations, then in this Clause refers to  (as defined in Clause 10.2) , and  is the number of elements in the set .

For TDD HARQ-ACK transmission with PUCCH format 4 and sub-frame  with  and more than one configured serving cell, where  is the number of elements in the set , the UE shall use PUCCH resource  or  or  for transmission of HARQ-ACK and scheduling request (if any) and periodic CSI (if any) in subframe  for  mapped to antenna port *p* where

- If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell,

- for a single PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe , where , and for a TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} the DAI value in the PDCCH is equal to '1' (defined in Table 7.3-X), or

- for a single PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where , and for a TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} the DAI value in the PDCCH is equal to '1',

- the UE shall use PUCCH format 1a/1b and PUCCH resource  with  for antenna port , where  is configured by higher layers,  is selected from {0, 1, 2, 3} such that , , and  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe  where . When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port  is given by 

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell,

- for a single PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe , where , and for a TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} the DAI value in the PDCCH is equal to '1' (defined in Table 7.3-X), or

- for a single PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where , and for a TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} the DAI value in the PDCCH is equal to '1',

- the UE shall use PUCCH format 1a/1b, and

- if the value of is same as the value of an element , where , the PUCCH resource  is given by ;

- otherwise, if the value of is same as the value of an element  in set , where (defined in Table 10.1.3.1-1A, where "UL/DL configuration" in the table refers to the higher layer parameter *subframeAssignment*), the PUCCH resource  is given by ;

where  is the number of elements in the set  defined in Table 10.1.3.1-1A , where  is selected from {0, 1, 2, 3} such that ,  where  is determined from the primary cell,  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe , and , , are configured by higher layers. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port  is given by 

- If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell,

- for a single PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe , where , and for a TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} the DAI value in the EPDCCH is equal to '1' (defined in Table 7.3-X), or

- for a single PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where , and for a TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} the DAI value in the EPDCCH is equal to '1',

- the UE shall use PUCCH format 1a/1b and PUCCH resource  given by

- If EPDCCH-PRB-set is configured for distributed transmission



- If EPDCCH-PRB-set is configured for localized transmission



where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter pucch-ResourceStartOffset-r11 , for EPDCCH-PRB-set in subframe is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3]. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.2.1-1. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.3.1-2. If the UE is configured to monitor EPDCCH in subframe ,  is equal to the number of ECCEs in EPDCCH-PRB-set configured for that UE in subframe . If the UE is not configured to monitor EPDCCH in subframe,  is equal to the number of ECCEs computed assuming EPDCCH-PRB-set is configured for that UE in subframe . For normal downlink CP, if subframe  is a special subframe with special subframe configuration 0, 5 or 10 if configured by *ssp10-CRS-LessDwPTS*, is equal to 0. For extended downlink CP, if subframe  is a special subframe with special subframe configuration 0 or 4 or 7, is equal to 0. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port  is given by .

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell,

- for a single PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe , where , and for a TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} the DAI value in the EPDCCH is equal to '1' (defined in Table 7.3-X), or

- for a single PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where , and for a TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} the DAI value in the EPDCCH is equal to '1',

- the UE shall use PUCCH format 1a/1b and PUCCH resource  given by

- if EPDCCH-PRB-set is configured for distributed transmission



- if EPDCCH-PRB-set is configured for localized transmission



where

- if the value of  is same as the value of an index , where , then ;

- otherwise, if the value of  is same as the value of an index , where , then ;

and where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter *pucch-ResourceStartOffset-r11 ,* for EPDCCH-PRB-set in subframe  is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3]. , , are determined as described in Clause 10.1.3.1. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port  is given by .

- for a single PDSCH transmission only on the primary cell where there is not a corresponding PDCCH/EPDCCH detected within subframe(s) , where  and no PDCCH/EPDCCH indicating downlink SPS release (defined in Clause 9.2) within subframe(s) , where , the UE shall use PUCCH format 1a/1b and PUCCH resource  with the value of  is determined according to higher layer configuration and Table 9.2-2. For a UE configured for two antenna port transmission for PUCCH format 1a/1b, a PUCCH resource value in Table 9.2-2 maps to two PUCCH resources with the first PUCCH resource  for antenna port  and the second PUCCH resource  for antenna port , otherwise, the PUCCH resource value maps to a single PUCCH resource  for antenna port .

- for , and

- for a PDSCH transmission only on the primary cell where there is not a corresponding PDCCH detected within subframe(s) , where , and

- for an additional PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe , where  with the DAI value in the PDCCH equal to '1' (defined in Table 7.3-X), or

- for an additional PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  with the DAI value in the PDCCH equal to '1',

- the UE shall transmit  in subframe  using PUCCH format 1b on PUCCH resource  selected from  PUCCH resources  where , according to Table 10.1.3.2-1 and Table 10.1.3.2-2 for  and , respectively. For a UE configured with a transmission mode that supports up to two transport blocks on the primary cell, ; otherwise, .

- If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource  is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource  is determined as , where  is configured by higher layers,  is selected from {0, 1, 2, 3} such that , , and  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe  where .

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource  is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource  is determined as

- if the value of is same as the value of an element , where , the PUCCH resource is given by ;

- otherwise, if the value of is same as the value of an element  in set , where (defined in Table 10.1.3.1-1A, where "UL/DL configuration" in the table refers to the higher layer parameter *subframeAssignment*), the PUCCH resource  is given by ;

where  is the number of elements in the set  defined in Table 10.1.3.1-1A , where  is selected from {0, 1, 2, 3} such that , ,  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe , and , , are configured by higher layers.

- For a UE configured with a transmission mode that supports up to two transport blocks on the primary cell, the PUCCH resource  is determined as .HARQ-ACK(0) is the ACK/NACK/DTX response for the PDSCH without a corresponding PDCCH detected. HARQ-ACK(1) is the ACK/NACK/DTX response for the first transport block of the PDSCH indicated by the detection of a corresponding PDCCH for which the value of the DAI field in the corresponding DCI format is equal to '1' or for the PDCCH indicating downlink SPS release for which the value of the DAI field in the corresponding DCI format is equal to '1'. HARQ-ACK(2) is the ACK/NACK/DTX response for the second transport block of the PDSCH indicated by the detection of a corresponding PDCCH for which the value of the DAI field in the corresponding DCI format is equal to '1'.

- for , and

- for a PDSCH transmission only on the primary cell where there is not a corresponding EPDCCH detected within subframe(s) , where  , and

- for an additional PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe , where  with the DAI value in the EPDCCH equal to '1' (defined in Table 7.3-X), or

- for an additional EPDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  with the DAI value in the EPDCCH equal to '1',

- the UE shall transmit  in subframe  using PUCCH format 1b on PUCCH resource  selected from  PUCCH resources  where , according to Table 10.1.3.2-1 and Table 10.1.3.2-2 for  and , respectively. For a UE configured with a transmission mode that supports up to two transport blocks on the primary cell, ; otherwise, .

- If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource  is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource  is determined as

- If EPDCCH-PRB-set is configured for distributed transmission



- If EPDCCH-PRB-set is configured for localized transmission



where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter pucch-ResourceStartOffset-r11 , for EPDCCH-PRB-set in subframe is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3]. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.2.1-1. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.3.1-2. If the UE is configured to monitor EPDCCH in subframe ,  is equal to the number of ECCEs in EPDCCH-PRB-set configured for that UE in subframe . If the UE is not configured to monitor EPDCCH in subframe,  is equal to the number of ECCEs computed assuming EPDCCH-PRB-set is configured for that UE in subframe. For normal downlink CP, if subframe  is a special subframe with special subframe configuration 0, 5 or 10 if configured by *ssp10-CRS-LessDwPTS*, is equal to 0. For extended downlink CP, if subframe  is a special subframe with special subframe configuration 0 or 4 or 7, is equal to 0.

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource  is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource  is determined as

- If EPDCCH-PRB-set is configured for distributed transmission



- If EPDCCH-PRB-set is configured for localized transmission



where

- if the value of  is same as the value of an index , where , then ;

- otherwise, if the value of  is same as the value of an index , where , then ;

- and where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter *pucch-ResourceStartOffset-r11 ,* for EPDCCH-PRB-set in subframe  is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3]. , , are determined as described in Clause 10.1.3.1.

- For a UE configured with a transmission mode that supports up to two transport blocks on the primary cell, the PUCCH resource  is determined as .HARQ-ACK(0) is the ACK/NACK/DTX response for the PDSCH without a corresponding EPDCCH detected. HARQ-ACK(1) is the ACK/NACK/DTX response for the first transport block of the PDSCH indicated by the detection of a corresponding EPDCCH for which the value of the DAI field in the corresponding DCI format is equal to '1' or for the EPDCCH indicating downlink SPS release for which the value of the DAI field in the corresponding DCI format is equal to '1'. HARQ-ACK(2) is the ACK/NACK/DTX response for the second transport block of the PDSCH indicated by the detection of a corresponding EPDCCH for which the value of the DAI field in the corresponding DCI format is equal to '1'.

- for , and

- for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe , where  with the DAI value in the PDCCH greater than '1' (defined in Table 7.3-X), or

- for a PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  with the DAI value in the PDCCH greater than '1', or

- for  and for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe , where  with the DAI value in the PDCCH equal to '1' (defined in Table 7.3-X) not being the first PDCCH/EPDCCH transmission in subframe(s) , where  with the DAI value equal to '1', or

- for  and for a PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  with the DAI value in the PDCCH equal to '1' (defined in Table 7.3-X) not being the first PDCCH/EPDCCH transmission in subframe(s) , where  with the DAI value equal to '1',

- if the total number of HARQ-ACK bits  and scheduling request bit (if any) and periodic CSI bits  (if any) is more than 22, the UE shall use PUCCH format 4 and PUCCH resource  where the value of  is determined according to higher layer configuration and Table 10.1.2.2.3-1 and the TPC field in a PDCCH assignment with DAI value greater than '1' (defined in Table 7.3-X) or with DAI value equal to '1', not being the first PDCCH/EPDCCH assignment in subframe(s) , where  with the DAI value equal to '1', shall be used to determine the PUCCH resource value from one of the four PUCCH resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.3-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted on all PDCCH assignments used to determine the PUCCH resource values within the subframe(s) , where .

- if the total number of HARQ-ACK bits  and scheduling request bit (if any) and periodic CSI bits  (if any) is no more than 22, the UE shall use PUCCH format 3 and PUCCH resource  where the value of  is determined according to higher layer configuration and Table 10.1.2.2.2-1 and the TPC field in a PDCCH assignment with DAI value greater than '1' (defined in Table 7.3-X) or with DAI value equal to '1', not being the first PDCCH/EPDCCH assignment in subframe(s) , where  with the DAI value equal to '1', shall be used to determine the PUCCH resource value from one of the four PUCCH resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.2-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted on all PDCCH assignments used to determine the PUCCH resource values within the subframe(s) , where .

- for , and

- for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe , where  with the DAI value in the EPDCCH greater than '1' (defined in Table 7.3-X), or

- for an EPDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  with the DAI value in the EPDCCH greater than '1', or

- for  and for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe , where  with the DAI value in the EPDCCH equal to '1' (defined in Table 7.3-X) not being the first PDCCH/EPDCCH transmission in subframe(s) , where  with the DAI value equal to '1', or

- for  and for an EPDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  with the DAI value in the EPDCCH equal to '1' (defined in Table 7.3-X) not being the first PDCCH/EPDCCH transmission in subframe(s) , where  with the DAI value equal to '1',

- if the total number of HARQ-ACK bits  and scheduling request bit (if any) and periodic CSI bits  (if any) is more than 22, the UE shall use PUCCH format 4 and PUCCH resource  where the value of  is determined according to higher layer configuration and Table 10.1.2.2.3-1 and the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH assignment with DAI value greater than '1' or with DAI value equal to '1' (defined in Table 7.3-X), not being the first PDCCH/EPDCCH assignment in subframe(s) , where  with the DAI value equal to '1', shall be used to determine the PUCCH resource value from one of the four PUCCH resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.3-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted on all EPDCCH assignments used to determine the PUCCH resource values within the subframe(s) , where .

- if the total number of HARQ-ACK bits  and scheduling request bit (if any) and periodic CSI bits  (if any) is no more than 22, the UE shall use PUCCH format 3 and PUCCH resource  where the value of  is determined according to higher layer configuration and Table 10.1.2.2.2-1 and the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH assignment with DAI value greater than '1' or with DAI value equal to '1' (defined in Table 7.3-X), not being the first PDCCH/EPDCCH assignment in subframe(s) , where  with the DAI value equal to '1', shall be used to determine the PUCCH resource value from one of the four PUCCH resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.2-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted on all EPDCCH assignments used to determine the PUCCH resource values within the subframe(s) , where .

- If the UL/DL configurations of all serving cells are the same and the total number of HARQ-ACK bits  and scheduling request bit (if any) and periodic CSI bits  (if any) is more than 22, for a PDSCH transmission on the secondary cell indicated by the detection of a corresponding PDCCH/EPDCCH within subframe(s) , where , the UE shall use PUCCH format 4 and PUCCH resource  where the value of  is determined according to higher layer configuration and Table 10.1.2.2.3-1 and the TPC field in the corresponding PDCCH/EPDCCH shall be used to determine the PUCCH resource value from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.3-1. For TDD UL/DL configurations 1-6, if a PDCCH corresponding to a PDSCH on the primary cell within subframe(s) , where , or a PDCCH indicating downlink SPS release (defined in Clause 9.2) within subframe(s) , where , is detected, the TPC field in the PDCCH with the DAI value greater than '1' or with DAI value equal to '1', not being the first PDCCH/EPDCCH transmission in subframe(s) , where  with the DAI value equal to '1' (defined in Table 7.3-X), shall be used to determine the PUCCH resource value from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.3-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted on all PDCCH assignments in the primary cell and in each secondary cell that are used to determined the PUCCH resource value within the subframe(s) , where . For TDD UL/DL configurations 1-6, if an EPDCCH corresponding to a PDSCH on the primary cell within subframe(s) , where , or an EPDCCH indicating downlink SPS release (defined in Clause 9.2) within subframe(s) , where , is detected, the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH assignment with the DAI value greater than '1' (defined in Table 7.3-X) or with DAI value equal to '1', not being the first PDCCH/EPDCCH transmission in subframe(s) , where  with the DAI value equal to '1', shall be used to determine the PUCCH resource value from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.3-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted on all EPDCCH assignments in the primary cell and in each secondary cell that are used to determined the PUCCH resource value within the subframe(s) , where .

- If the UL/DL configurations of at least two serving cells are different and the total number of HARQ-ACK bits  and scheduling request bit (if any) and periodic CSI bits  (if any) is more than 22, for a PDSCH transmission on the secondary cell indicated by the detection of a corresponding PDCCH/EPDCCH within subframe(s) , where , the UE shall use PUCCH format 4 and PUCCH resource  where the value of  is determined according to higher layer configuration and Table 10.1.2.2.3-1 and the TPC field in the corresponding PDCCH/EPDCCH shall be used to determine the PUCCH resource value from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.3-1. For a UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} as defined in Clause 10.2, if a PDCCH corresponding to a PDSCH on the primary cell within subframe(s) , where , or a PDCCH indicating downlink SPS release (defined in Clause 9.2) within subframe(s) , where , is detected, the TPC field in the PDCCH with the DAI value greater than '1' (defined in Table 7.3-X) or with DAI value equal to '1', not being the first PDCCH/EPDCCH transmission in subframe(s) , where  with the DAI value equal to '1', shall be used to determine the PUCCH resource value from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.3-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted on all PDCCH assignments in the primary cell and in each secondary cell that are used to determined the PUCCH resource value within the subframe(s) , where . For a UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} as defined in Clause 10.2, if an EPDCCH corresponding to a PDSCH on the primary cell within subframe(s) , where , or an EPDCCH indicating downlink SPS release (defined in Clause 9.2) within subframe(s) , where , is detected, the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH assignment with the DAI value greater than '1' or with DAI value equal to '1', not being the first PDCCH/EPDCCH transmission in subframe(s) , where  with the DAI value equal to '1', shall be used to determine the PUCCH resource value from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.3-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted on all EPDCCH assignments in the primary cell and in each secondary cell that are used to determined the PUCCH resource value within the subframe(s) , where .

- If the UL/DL configurations of all serving cells are the same, and the total number of HARQ-ACK bits  and scheduling request bit (if any) and periodic CSI bits  (if any) is no more than 22, for a PDSCH transmission on the secondary cell indicated by the detection of a corresponding PDCCH/EPDCCH within subframe(s) , where , the UE shall use PUCCH format 3 and PUCCH resource  where the value of  is determined according to higher layer configuration and Table 10.1.2.2.2-1 and the TPC field in the corresponding PDCCH/EPDCCH shall be used to determine the PUCCH resource value from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.2-1. For TDD UL/DL configurations 1-6, if a PDCCH corresponding to a PDSCH on the primary cell within subframe(s) , where , or a PDCCH indicating downlink SPS release (defined in clause 9.2) within subframe(s) , where , is detected, the TPC field in the PDCCH with the DAI value greater than '1' or with DAI value equal to '1', not being the first PDCCH/EPDCCH transmission in subframe(s) , where  with the DAI value equal to '1' (defined in Table 7.3-X), shall be used to determine the PUCCH resource value from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.2-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted on all PDCCH assignments in the primary cell and in each secondary cell that are used to determined the PUCCH resource value within the subframe(s) , where . For TDD UL/DL configurations 1-6, if an EPDCCH corresponding to a PDSCH on the primary cell within subframe(s) , where , or an EPDCCH indicating downlink SPS release (defined in clause 9.2) within subframe(s) , where , is detected, the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH assignment with the DAI value greater than '1' (defined in Table 7.3-X) or with DAI value equal to '1', not being the first PDCCH/EPDCCH transmission in subframe(s) , where  with the DAI value equal to '1', shall be used to determine the PUCCH resource value from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.2-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted on all EPDCCH assignments in the primary cell and in each secondary cell that are used to determined the PUCCH resource value within the subframe(s) , where . For a UE configured for two antenna port transmission for PUCCH format 3, a PUCCH resource value in Table 10.1.2.2.2-1 maps to two PUCCH resources with the first PUCCH resourcefor antenna portand the second PUCCH resourcefor antenna port, otherwise, the PUCCH resource value maps to a single PUCCH resourcefor antenna port.

- If the UL/DL configurations of at least two serving cells are different and the total number of HARQ-ACK bits  and scheduling request bit (if any) and periodic CSI bits  (if any) is no more than 22, for a PDSCH transmission on the secondary cell indicated by the detection of a corresponding PDCCH/EPDCCH within subframe(s) , where , the UE shall use PUCCH format 3 and PUCCH resource  where the value of  is determined according to higher layer configuration and Table 10.1.2.2.2-1 and the TPC field in the corresponding PDCCH/EPDCCH shall be used to determine the PUCCH resource value from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.2-1. For a UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} as defined in clause 10.2, if a PDCCH corresponding to a PDSCH on the primary cell within subframe(s) , where , or a PDCCH indicating downlink SPS release (defined in clause 9.2) within subframe(s) , where , is detected, the TPC field in the PDCCH with the DAI value greater than '1' (defined in Table 7.3-X) or with DAI value equal to '1', not being the first PDCCH/EPDCCH transmission in subframe(s) , where  with the DAI value equal to '1', shall be used to determine the PUCCH resource value from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.2-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted on all PDCCH assignments in the primary cell and in each secondary cell that are used to determined the PUCCH resource value within the subframe(s) , where . For a UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} as defined in clause 10.2, if an EPDCCH corresponding to a PDSCH on the primary cell within subframe(s) , where , or an EPDCCH indicating downlink SPS release (defined in clause 9.2) within subframe(s) , where , is detected, the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH assignment with the DAI value greater than '1' or with DAI value equal to '1', not being the first PDCCH/EPDCCH transmission in subframe(s) , where  with the DAI value equal to '1', shall be used to determine the PUCCH resource value from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.2-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted on all EPDCCH assignments in the primary cell and in each secondary cell that are used to determined the PUCCH resource value within the subframe(s) , where . For a UE configured for two antenna port transmission for PUCCH format 3, a PUCCH resource value in Table 10.1.2.2.2-1 maps to two PUCCH resources with the first PUCCH resourcefor antenna portand the second PUCCH resourcefor antenna port, otherwise, the PUCCH resource value maps to a single PUCCH resourcefor antenna port.

10.1.3.2.3.2 PUCCH format 4 HARQ-ACK procedure with adaptive codebook

The procedure in this Clause applies to a UE configured with PUCCH format 4 and *codebooksizeDetermination-r13 = dai*.

If a UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12*, then where the set  is defined in Table 10.1.3.1-1 (where "UL/DL configuration" in the table refers to the higher layer parameter *subframeAssignment*), and is the number of elements in set .

If a UE is configured with more than one serving cells and the UL/DL configuration of all serving cells is same, then in the rest of this Clause  is as defined in Sec 10.2, and  is the number of elements in the set .

If a UE is configured with more than one serving cell and if at least two cells have different UL/DL configurations, then in this Clause refers to  (as defined in Clause 10.2) , and  is the number of elements in the set .

For TDD HARQ-ACK transmission with PUCCH format 4 and sub-frame  with  and more than one configured serving cell, where  is the number of elements in the set , the UE shall use PUCCH resource  or  or  for transmission of HARQ-ACK and scheduling request (if any) and periodic CSI (if any) in subframe  for  mapped to antenna port *p* where

- If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell,

- for a single PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe , where , and both the counter DAI value and the total DAI value in the PDCCH are equal to '1' (defined in Table 7.3.2.1-1), or

- for a single PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where , and both the counter DAI value and the total DAI value in the PDCCH are equal to '1',

- the UE shall use PUCCH format 1a/1b and PUCCH resource  with  for antenna port , where  is configured by higher layers,  is selected from {0, 1, 2, 3} such that , , and  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe  where . When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port  is given by 

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell,

- for a single PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe , where , and both the counter DAI value and the total DAI value in the PDCCH are equal to '1' (defined in Table 7.3.2.1-1), or

- for a single PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where , and both the counter DAI value and the total DAI value in the PDCCH are equal to '1',

- the UE shall use PUCCH format 1a/1b, and

- if the value of is same as the value of an element , where , the PUCCH resource  is given by ;

- otherwise, if the value of is same as the value of an element  in set , where (defined in Table 10.1.3.1-1A, where "UL/DL configuration" in the table refers to the higher layer parameter *subframeAssignment*), the PUCCH resource  is given by ;

where  is the number of elements in the set  defined in Table 10.1.3.1-1A , where  is selected from {0, 1, 2, 3} such that ,  where  is determined from the primary cell,  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe , and , , are configured by higher layers. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port  is given by 

- If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell,

- for a single PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe , where , and both the counter DAI value and the total DAI value in the EPDCCH are equal to '1' (defined in Table 7.3.2.1-1), or

- for a single EPDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where , and both the counter DAI value and the total DAI value in the EPDCCH are equal to '1',

- the UE shall use PUCCH format 1a/1b and PUCCH resource  given by

- If EPDCCH-PRB-set is configured for distributed transmission



- If EPDCCH-PRB-set is configured for localized transmission



where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter pucch-ResourceStartOffset-r11 , for EPDCCH-PRB-set in subframe is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3]. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.2.1-1. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.3.1-2. If the UE is configured to monitor EPDCCH in subframe ,  is equal to the number of ECCEs in EPDCCH-PRB-set configured for that UE in subframe . If the UE is not configured to monitor EPDCCH in subframe,  is equal to the number of ECCEs computed assuming EPDCCH-PRB-set is configured for that UE in subframe . For normal downlink CP, if subframe  is a special subframe with special subframe configuration 0 or 5, is equal to 0. For extended downlink CP, if subframe  is a special subframe with special subframe configuration 0 or 4 or 7, is equal to 0. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port  is given by .

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell,

- for a single PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe , where , and both the counter DAI value and the total DAI value in the EPDCCH are equal to '1' (defined in Table 7.3.2.1-1), or

- for a single EPDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where , and both the counter DAI value and the total DAI value in the EPDCCH are equal to '1',

- the UE shall use PUCCH format 1a/1b and PUCCH resource  given by

- if EPDCCH-PRB-set is configured for distributed transmission



- if EPDCCH-PRB-set is configured for localized transmission



where

- if the value of  is same as the value of an index , where , then ;

- otherwise, if the value of  is same as the value of an index , where , then ;

and where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter *pucch-ResourceStartOffset-r11 ,* for EPDCCH-PRB-set in subframe  is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3]. , , are determined as described in Clause 10.1.3.1. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port  is given by .

- for a single PDSCH transmission only on the primary cell where there is not a corresponding PDCCH/EPDCCH detected within subframe(s) , where  and no PDCCH/EPDCCH indicating downlink SPS release (defined in Clause 9.2) within subframe(s) , where , the UE shall use PUCCH format 1a/1b and PUCCH resource  with the value of  is determined according to higher layer configuration and Table 9.2-2. For a UE configured for two antenna port transmission for PUCCH format 1a/1b, a PUCCH resource value in Table 9.2-2 maps to two PUCCH resources with the first PUCCH resource  for antenna port  and the second PUCCH resource  for antenna port , otherwise, the PUCCH resource value maps to a single PUCCH resource  for antenna port .

- for , and

- for a PDSCH transmission only on the primary cell where there is not a corresponding PDCCH detected within subframe(s) , where , and

- for an additional PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe , where  with both the counter DAI value and the total DAI value in the PDCCH equal to '1' (defined in Table 7.3.2.1-1), or

- for an additional PDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  with both the counter DAI value and the total DAI value in the PDCCH equal to '1',

- the UE shall transmit  in subframe  using PUCCH format 1b on PUCCH resource  selected from  PUCCH resources  where , according to Table 10.1.3.2-1 and Table 10.1.3.2-2 for  and , respectively. For a UE configured with a transmission mode that supports up to two transport blocks on the primary cell, ; otherwise, .

- If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource  is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource  is determined as , where  is configured by higher layers,  is selected from {0, 1, 2, 3} such that , , and  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe  where .

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource  is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource  is determined as

- if the value of is same as the value of an element , where , the PUCCH resource is given by ;

- otherwise, if the value of is same as the value of an element  in set , where (defined in Table 10.1.3.1-1A, where "UL/DL configuration" in the table refers to the higher layer parameter *subframeAssignment*), the PUCCH resource  is given by ;

where  is the number of elements in the set  defined in Table 10.1.3.1-1A , where  is selected from {0, 1, 2, 3} such that , ,  is the number of the first CCE used for transmission of the corresponding PDCCH in subframe , and , , are configured by higher layers.

- For a UE configured with a transmission mode that supports up to two transport blocks on the primary cell, the PUCCH resource  is determined as .HARQ-ACK(0) is the ACK/NACK/DTX response for the PDSCH without a corresponding PDCCH detected. HARQ-ACK(1) is the ACK/NACK/DTX response for the first transport block of the PDSCH indicated by the detection of a corresponding PDCCH for which the value of both the counter DAI field and total DAI field in the corresponding DCI format is equal to '1' or for the PDCCH indicating downlink SPS release for which the value of both the counter DAI field and total DAI field in the corresponding DCI format is equal to '1'. HARQ-ACK(2) is the ACK/NACK/DTX response for the second transport block of the PDSCH indicated by the detection of a corresponding PDCCH for which the value of both the counter DAI field and the total DAI field in the corresponding DCI format is equal to '1'.

- for , and

- for a PDSCH transmission only on the primary cell where there is not a corresponding EPDCCH detected within subframe(s) , where  , and

- for an additional PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe , where  with both the counter DAI value and the total DAI value in the EPDCCH equal to '1' (defined in Table 7.3.2.1-1), or

- for an additional EPDCCH indicating downlink SPS release (defined in Clause 9.2) in subframe , where  with both the counter DAI value and the total DAI value in the EPDCCH equal to '1',

- the UE shall transmit  in subframe  using PUCCH format 1b on PUCCH resource  selected from  PUCCH resources  where , according to Table 10.1.3.2-1 and Table 10.1.3.2-2 for  and , respectively. For a UE configured with a transmission mode that supports up to two transport blocks on the primary cell, ; otherwise, .

- If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource  is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource  is determined as

- If EPDCCH-PRB-set is configured for distributed transmission



- If EPDCCH-PRB-set is configured for localized transmission



where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter pucch-ResourceStartOffset-r11 , for EPDCCH-PRB-set in subframe is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3]. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.2.1-1. If ,  is determined from the HARQ-ACK resource offset field in the DCI format of the corresponding EPDCCH as given in Table 10.1.3.1-2. If the UE is configured to monitor EPDCCH in subframe ,  is equal to the number of ECCEs in EPDCCH-PRB-set configured for that UE in subframe . If the UE is not configured to monitor EPDCCH in subframe,  is equal to the number of ECCEs computed assuming EPDCCH-PRB-set is configured for that UE in subframe. For normal downlink CP, if subframe  is a special subframe with special subframe configuration 0 or 5, is equal to 0. For extended downlink CP, if subframe  is a special subframe with special subframe configuration 0 or 4 or 7, is equal to 0.

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource  is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource  is determined as

- If EPDCCH-PRB-set is configured for distributed transmission



- If EPDCCH-PRB-set is configured for localized transmission



where

- if the value of  is same as the value of an index , where , then ;

- otherwise, if the value of  is same as the value of an index , where , then ;

- and where  is the number of the first ECCE (i.e. lowest ECCE index used to construct the EPDCCH) used for transmission of the corresponding DCI assignment in EPDCCH-PRB-set in subframe ,  for EPDCCH-PRB-set is configured by the higher layer parameter *pucch-ResourceStartOffset-r11 ,* for EPDCCH-PRB-set in subframe  is given in Clause 6.8A.1 in [3], is determined from the antenna port used for EPDCCH transmission in subframe which is described in Clause 6.8A.5 in [3]. , , are determined as described in Clause 10.1.3.1.

- For a UE configured with a transmission mode that supports up to two transport blocks on the primary cell, the PUCCH resource  is determined as .HARQ-ACK(0) is the ACK/NACK/DTX response for the PDSCH without a corresponding EPDCCH detected. HARQ-ACK(1) is the ACK/NACK/DTX response for the first transport block of the PDSCH indicated by the detection of a corresponding EPDCCH for which the value of both the counter DAI field and the total DAI field in the corresponding DCI format is equal to '1' or for the EPDCCH indicating downlink SPS release for which the value of both the counter DAI field and the total DAI field in the corresponding DCI format is equal to '1'. HARQ-ACK(2) is the ACK/NACK/DTX response for the second transport block of the PDSCH indicated by the detection of a corresponding EPDCCH for which the value of both the counter DAI field and the total DAI field in the corresponding DCI format is equal to '1'.

- if a PDSCH transmission is indicated by the detection of a corresponding PDCCH/EPDCCH in subframe , where  with either the counter DAI value or the total DAI value in the PDCCH/EPDCCH greater than '1' (defined in Table 7.3.2.1-1) on the primary cell, or

- if a PDCCH/EPDCCH indicating downlink SPS release (defined in Clause 9.2) is detected in subframe , where  with either the counter DAI value or the total DAI value in the PDCCH/EPDCCH greater than '1' on the primary cell, or

- if a PDSCH transmission is indicated by the detection of a corresponding PDCCH/EPDCCH in subframe , where  on a secondary cell,

- if the total number of HARQ-ACK bits  and scheduling request bit (if any) and periodic CSI bits  (if any) is more than 22, the UE shall use PUCCH format 4 and PUCCCH resource  where the value of  is determined according to higher layer configuration and Table 10.1.2.2.3-1. Denote  as the set of configured serving cells for the UE. Denote  is the smallest value in  such that PDCCH/EPDCCH scheduling PDSCH or indicating DL SPS release is detected in subframe on serving cell and . The TPC field in a PDCCH/EPDCCH scheduling PDSCH or indicating downlink SPS release in subframe  on a serving cell  satisfying  shall be used to determine the PUCCH resource value from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.3-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted on any PDCCH/EPDCCH scheduling PDSCH or indicating downlink SPS release in subframe  on any serving cell  satisfying.

- if the total number of HARQ-ACK bits  and scheduling request bit (if any) and periodic CSI bits  (if any) is no more than 22, the UE shall use PUCCH format 3 and PUCCH resource  where the value of  is determined according to higher layer configuration and Table 10.1.2.2.2-1. Denote  as the set of configured serving cells for the UE. Denote  is the smallest value in  such that PDCCH/EPDCCH scheduling PDSCH or indicating DL SPS release is detected in subframe on serving cell and . The TPC field in a PDCCH/EPDCCH scheduling PDSCH or indicating downlink SPS release in subframe  on a serving cell  satisfying  shall be used to determine the PUCCH resource value from one of the four resource values configured by higher layers, with the mapping defined in Table 10.1.2.2.2-1. A UE shall assume that the same HARQ-ACK PUCCH resource value is transmitted on any PDCCH/EPDCCH scheduling PDSCH or indicating downlink SPS release in subframe  on any serving cell  satisfying. If a UE is configured for two antenna port transmission for PUCCH format 3, a PUCCH resource value in Table 10.1.2.2.2-1 maps to two PUCCH resources with the first PUCCH resource  for antenna port  and the second PUCCH resource  for antenna port , otherwise, the PUCCH resource value maps to a single PUCCH resource  for antenna port .

##### 10.1.3.2.4 PUCCH format 5 HARQ-ACK procedure

TDD HARQ-ACK feedback procedures for a UE configured with PUCCH format 5 and *codebooksizeDetermination-r13 = cc* is described in Clause 10.1.3.2.4.1.

TDD HARQ-ACK feedback procedures for a UE configured with PUCCH format 5 and *codebooksizeDetermination-r13 = dai* is described in Clause 10.1.3.2.4.2.

10.1.3.2.4.1 PUCCH format 5 HARQ-ACK procedure without adaptive codebook

The HARQ-ACK feedback procedure for PUCCH format 5 HARQ-ACK procedure is as described in Clause 10.1.3.2.3.1, by replacing with.

10.1.3.2.4.2 PUCCH format 5 HARQ-ACK procedure with adaptive codebook

The HARQ-ACK feedback procedure for PUCCH format 5 HARQ-ACK procedure is as described in Clause 10.1.3.2.3.2, by replacing with .

### 10.1.3A FDD-TDD HARQ-ACK feedback procedures for primary cell frame structure type 2

A UE is configured by higher layers to use either PUCCH format 1b with channel selection or PUCCH format 3/4/5 for transmission of HARQ-ACK.

For a serving cell, if the serving cell is frame structure type 1, and a UE is not configured to monitor PDCCH/EPDCCH in another serving cell for scheduling the serving cell, set is defined in Table 10.1.3A-1, otherwise set is defined in Table 10.1.3.1-1C if the UE is configured with higher layer parameter *shortTTI* for slot-PDSCH, in Table 10.1.3.1-1B if the UE is configured with higher layer parameter *shortProcessingTime* and the corresponding PDCCH with CRC scrambled by C-RNTI is in the UE-specific search space for subframe-PDSCH and in Table 10.1.3.1-1 otherwise.

PUCCH format 1b with channel selection is not supported if a UE is configured with more than two serving cells, or if the DL-reference UL/DL configuration 5 (as defined in Clause 10.2) is defined for any serving cell, or if the DL-reference UL/DL configuration of a serving cell with frame structure type 1 belongs to {2, 3, 4} and the UE is not configured to monitor PDCCH/EPDCCH in another serving cell for scheduling the serving cell.

If a UE is configured with the parameter *EIMTA-MainConfigServCell-r12* for at least one serving cell and is configured with PUCCH format 3 without PUCCH format 4/5 configured, the UE is not expected to be configured with more than two serving cells having DL-reference UL/DL configuration 5.

If a UE is configured to use PUCCH format 1b with channel selection for HARQ-ACK transmission, for the serving cells,

- if more than 4 HARQ-ACK bits for multiple downlink and special subframes associated with a single UL subframe *n*, where  is as defined in Clause 10.1.3.2.1 for case where the UE is configured with two serving cells with different UL/DL configurations,

- spatial HARQ-ACK bundling across multiple codewords within a downlink or special subframe is performed for each serving cell by a logical AND operation of all the corresponding individual HARQ-ACKs, and the bundled HARQ-ACK bits for each serving cell is transmitted using PUCCH format 1b with channel selection,

- otherwise,

- spatial HARQ-ACK bundling is not performed, and the HARQ-ACK bits are transmitted using PUCCH format 1b with channel selection.

If a UE is configured to use PUCCH format 3 without PUCCH format 4/5 configured for HARQ-ACK transmission, for the serving cells,

- if more than 21 HARQ-ACK bits for  multiple subframes in downlink and special subframes associated with a single UL subframe *n*, where  as defined in Clause 10.1.3.2.2 for the case of UE configured with more than one serving cell and if at least two cells have different UL/DL configurations,

- spatial HARQ-ACK bundling across multiple codewords within a downlink subframe or a special subframe is performed for each serving cell by a logical AND operation of all of the corresponding individual HARQ-ACKs, and PUCCH format 3 is used,

- otherwise,

- spatial HARQ-ACK bundling is not performed, and the HARQ-ACK bits are transmitted using PUCCH format 3.

- UE shall determine the number of HARQ-ACK bits, , associated with an UL subframe/slot *n* according to  where  is the number of configured cells, and is the number of HARQ-bits for the *c*-th serving cell defined in Clause 7.3.4. If a UE is not configured to monitor PDCCH/EPDCCH/SPDCCH in another serving cell for scheduling a serving cell with frame structure type 1, and the DL-reference UL/DL configuration of the serving cell belongs to {2, 3, 4, 5}, then the UE is not expected to be configured with  which result in .

HARQ-ACK transmission on two antenna ports  is supported for PUCCH format 3.

HARQ-ACK transmission on two antenna ports  is supported for PUCCH format 1b with channel selection and with two configured serving cells.

The FDD-TDD HARQ-ACK feedback procedure for PUCCH format 1b with channel selection follows the HARQ-ACK procedure described in Clause 10.1.3.2.1 for the case of UE configured with two serving cells with different UL/DL configurations, and for PUCCH format 3/4/5 follows the HARQ-ACK procedure described in Clause 10.1.3.2.2/10.1.3.2.3/10.2.3.2.4 for the case of UE configured with more than one serving cell and if at least two cells have different UL/DL configurations.

Table 10.1.3A-1: Downlink association set *:*  for FDD-TDD and serving cell frame structure type 1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DL-reference UL/DL  Configuration | Subframe *n* | | | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 0 | - | - | 6, 5 | 5, 4 | 4 | - | - | 6, 5 | 5, 4 | 4 |
| 1 | - | - | 7, 6 | 6, 5, 4 | - | - | - | 7, 6 | 6, 5, 4 | - |
| 2 | - | - | 8, 7, 6, 5, 4 | - | - | - | - | 8, 7, 6, 5, 4 | - | - |
| 3 | - | - | 11, 10, 9, 8, 7, 6 | 6, 5 | 5, 4 | - | - | - | - | - |
| 4 | - | - | 12, 11, 10, 9, 8, 7 | 7, 6, 5, 4 | - | - | - | - | - | - |
| 5 | - | - | 13, 12, 11, 10, 9, 8, 7, 6, 5, 4 | - | - | - | - | - | - | - |
| 6 | - | - | 8, 7 | 7, 6 | 6, 5 | - | - | 7 | 7, 6, 5 | - |

### 10.1.4 HARQ-ACK Repetition procedure

For a non-BL/CE UE, HARQ-ACK repetition is enabled or disabled by a UE specific parameter *ackNackRepetition* configured by higher layers. Once enabled, the UE shall repeat any HARQ-ACK transmission with a repetition factor , where  is provided by higher layers and includes the initial HARQ-ACK transmission, until HARQ-ACK repetition is disabled by higher layers. For a PDSCH transmission without a corresponding PDCCH/EPDCCH detected, the UE shall transmit the corresponding HARQ-ACK response  times using PUCCH resource  configured by higher layers. For a PDSCH transmission with a corresponding PDCCH/EPDCCH detected, or for a PDCCH/EPDCCH indicating downlink SPS release, the UE shall first transmit the corresponding HARQ-ACK response once using PUCCH resource derived from the corresponding PDCCH CCE index or EPDCCH ECCE index (as described in Clauses 10.1.2 and 10.1.3), and repeat the transmission of the corresponding HARQ-ACK response  times always using PUCCH resource , where is configured by higher layers.

HARQ-ACK repetition is only applicable for UEs configured with one serving cell for FDD and TDD. For TDD, HARQ-ACK repetition is only applicable for HARQ-ACK bundling.

HARQ-ACK repetition can be enabled with PUCCH format 1a/1b on two antenna ports. For a UE configured for two antenna port transmission for HARQ-ACK repetition with PUCCH format 1a/1b, a PUCCH resource value  maps to two PUCCH resources with the first PUCCH resource  for antenna port  and the second PUCCH resource for antenna port , otherwise, the PUCCH resource value maps to a single PUCCH resource  for antenna port .

### 10.1.5 Scheduling Request (SR) procedure

A non-BL/CE UE is configured by higher layers to transmit the SR on one antenna port or two antenna ports.   
For a non-BL/CE UE, the scheduling request shall be transmitted on the PUCCH resource(s) for  mapped to antenna port *p* as defined in [3], where  is configured by higher layers unless the SR coincides in time with the transmission of HARQ-ACK using PUCCH Format 3/4/5 in which case the SR is multiplexed with HARQ-ACK according to Clause 5.2.3.1 of [4]. The subframe-SR configuration for SR transmission periodicity and SR subframe offset  is defined in Table 10.1.5-1 by the parameter *sr-ConfigIndex*  given by higher layers.

Subframe-SR transmission instances are the uplink subframes satisfying .

The slot-SR configuration for SR transmission periodicity  and SR slot offset  is defined in Table 10.1.5-1A by the parameter *sr-ConfigIndexSlot*  given by higher layers.

Slot-SR transmission instances are the uplink slots satisfying

.

The subslot-SR configuration for SR transmission periodicity  and SR subslot offset  is defined in Table 10.1.5-1B by the parameter *sr-ConfigIndexSubslot*  given by higher layers.

Subslot-SR transmission instances are the uplink slots satisfying

, where  is the subslot index within a subframe.

For a BL/CE UE, the scheduling request shall be transmitted on the PUCCH resource(s)  mapped to antenna port as defined in [3], where  is configured by higher layers. The SR configuration for SR transmission periodicity and SR subframe offset  is defined in Table 10.1.5-1 by the parameter *sr-ConfigIndex*  given by higher layers. The SR transmission instances are  consecutive BL/CE uplink subframes when >1, or one uplink subframe (which may or may not be a BL/CE UL subframe) when =1, where is provided by higher layer parameter *NumRepetitionCE-format1*, starting from a subframe satisfying .



Table 10.1.5-1: UE-specific SR periodicity and subframe offset configuration for subframe-SR

|  |  |  |
| --- | --- | --- |
| SR configuration Index | SR periodicity (ms) | SR subframe offset |
| 0 – 4 | 5 |  |
| 5 – 14 | 10 |  |
| 15 – 34 | 20 |  |
| 35 – 74 | 40 |  |
| 75 – 154 | 80 |  |
| 155 – 156 | 2 |  |
| 157 | 1 |  |

Table 10.1.5-1A: UE-specific SR periodicity and slot offset configuration for slot-SR

|  |  |  |
| --- | --- | --- |
| SR configuration Index | SR periodicity (number of slots) | SR slot offset |
| 0 | 1 |  |
| 1 – 2 | 2 |  |
| 3 – 6 | 4 |  |
| 7 – 16 | 10 |  |
| 17 – 36 | 20 |  |

Table 10.1.5-1B: UE-specific SR periodicity and subslot offset configuration for subslot-SR

|  |  |  |
| --- | --- | --- |
| SR configuration Index | SR periodicity (number of subslots) | SR subslot offset |
| 0 | 1 |  |
| 1 – 2 | 2 |  |
| 3 – 5 | 3 |  |
| 6 – 9 | 4 |  |
| 10 – 14 | 5 |  |
| 15 – 20 | 6 |  |
| 21 – 32 | 12 |  |
| 33 – 62 | 30 |  |
| 63 – 122 | 60 |  |

## 10.2 Uplink HARQ-ACK timing

For TDD or for FDD-TDD and primary cell frame structure type 2 or for FDD-TDD and primary cell frame structure type 1, if a UE configured with *EIMTA-MainConfigServCell-r12* for a serving cell, "UL/DL configuration" of the serving cell in Clause 10.2 refers to the UL/DL configuration given by the parameter *eimta-HARQ-ReferenceConfig-r12* for the serving cell unless specified otherwise.

For TDD serving cell not configured for PUSCH/PUCCH transmission, "UL/DL configuration" of the serving cell in Clause 10.2 refers to the UL/DL configuration given by the parameter *harq-ReferenceConfig-r14* for the serving cell unless specified otherwise

For a non-BL/CE UE, for FDD or for FDD-TDD and primary cell frame structure type 1, the UE shall upon detection of a PDSCH transmission in subframe *n-4* intended for the UE and for which an HARQ-ACK shall be provided, transmit the HARQ-ACK response in subframe *n*. If HARQ-ACK repetition is enabled, upon detection of a PDSCH transmission in subframe *n-4* intended for the UE and for which HARQ-ACK response shall be provided, and if the UE is not repeating the transmission of any HARQ-ACK in subframe  corresponding to a PDSCH transmission in subframes , … , , the UE:

- shall transmit only the HARQ-ACK response (corresponding to the detected PDSCH transmission in subframe ) on PUCCH in subframes , , …, ;

- shall not transmit any other signal/channel in subframes , , …, ; and

- shall not transmit any HARQ-ACK response repetitions corresponding to any detected PDSCH transmission in subframes , …, .

For TDD and a UE configured with *EIMTA-MainConfigServCell-r12* for at least one 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 DL-reference UL/DL configuration for a serving cell is the UL/DL configuration of the serving cell.

For FDD-TDD and primary cell frame structure type 1, if a serving cell is a secondary serving cell with frame structure type 2, the DL-reference UL/DL configuration for the serving cell is the UL/DL configuration of the serving cell.

For TDD, if the UE is configured with more than one serving cell and if at least two serving cells have different UL/DL configurations and if a serving cell is a primary cell, then the primary cell UL/DL configuration is the DL-reference UL/DL configuration for the serving cell.

For FDD-TDD and primary cell frame structure type 2, if a serving cell is a primary cell or if a serving cell is a secondary cell with frame structure type 1, then the primary cell UL/DL configuration is the DL-reference UL/DL configuration for the serving cell.

For TDD and if the UE is configured with more than one serving cell and if at least two serving cells have different UL/DL configurations and if the UE is not configured with *harqTimingTDD = TRUE* and if a serving cell is a secondary cell, or for FDD-TDD and primary cell frame structure type 2 and if the UE is not configured with *harqTimingTDD = TRUE* and if a serving cell is a secondary cell with frame structure type 2

- if the pair formed by (primary cell UL/DL configuration, serving cell UL/DL configuration ) belongs to Set 1 in Table 10.2-1 or

- if the UE is not configured to monitor PDCCH/EPDCCH in another serving cell for scheduling the serving cell, and if the pair formed by (primary cell UL/DL configuration, serving cell UL/DL configuration ) belongs to Set 2 or Set 3 in Table 10.2-1 or

- if the UE is configured to monitor PDCCH/EPDCCH in another serving cell for scheduling the serving cell, and if the pair formed by (primary cell UL/DL configuration, serving cell UL/DL configuration) belongs to Set 4 or Set 5 in Table 10.2-1

then the DL-reference UL/DL configuration for the serving cell is defined in the corresponding Set in Table 10.2-1.

For TDD and if the UE is configured with more than one serving cell and if at least two serving cells have different UL/DL configurations and if the UE is configured with *harqTimingTDD = TRUE* and if a serving cell is a secondary cell, or for FDD-TDD and primary cell frame structure type 2 and if the UE is configured with *harqTimingTDD = TRUE* and if a serving cell is a secondary cell with frame structure type 2

- if the UE is configured to monitor PDCCH/EPDCCH in another serving cell for scheduling the serving cell, and if the pair formed by (primary cell UL/DL configuration, serving cell UL/DL configuration) belongs to Set 1 or Set 4 or Set 5 in Table 10.2-1, then the DL-reference UL/DL configuration for the serving cell is defined in the corresponding Set in Table 10.2-1;

- if the UE is not configured to monitor PDCCH/EPDCCH in another serving cell for scheduling the serving cell, and then the primary cell UL/DL configuration is the DL-reference UL/DL configuration for the serving cell.

For a UE not configured with PUCCH format 4 or PUCCH format 5, for TDD and if a UE is configured with more than one serving cell and if at least two serving cells have different UL/DL configurations or for FDD-TDD and primary cell frame structure type 2, if the DL-reference UL/DL configuration for at least one serving cell is TDD UL/DL Configuration 5, then the UE is not expected to be configured with more than two serving cells.

For TDD and a non-BL/CE UE not configured with *EIMTA-MainConfigServCell-r12* for any serving cell, if the UE is configured with one serving cell, or the UE is configured with more than one serving cell and the UL/DL configurations of all serving cells is same, then the UE shall upon detection of a PDSCH transmission within subframe(s) , where  and  is defined in Table 10.1.3.1-1 intended for the UE and for which HARQ-ACK response shall be provided, transmit the HARQ-ACK response in UL subframe *n*.

For a UE not configured with *harqTimingTDD = TRUE*, for TDD and if a UE is configured with more than one serving cell and if at least two serving cells have different UL/DL configurations, or if a UE is configured with *EIMTA-MainConfigServCell-r12* for at least one serving cell, or for FDD-TDD and primary cell frame structure type 2 and if a serving cell *c* is frame structure type 2, then the UE shall upon detection of a PDSCH transmission within subframe(s)  for serving cell , where  intended for the UE and for which HARQ-ACK response shall be provided, transmit the HARQ-ACK response in UL subframe *n*, wherein set contains values of such that subframe *n-k* corresponds to a DL subframe or a special subframe for serving cell , where DL subframe or special subframe of serving cell  is according to the higher layer parameter *eimta-HARQ-ReferenceConfig-r12* if the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* for serving cell  and according to *harq-ReferenceConfig-r14* if configured*;*  defined in Table 10.1.3.1-1 (where "UL/DL configuration" in Table 10.1.3.1-1 refers to the "DL-reference UL/DL configuration") is associated with subframe *n.*

For a UE configured with *harqTimingTDD = TRUE*, for TDD and if a UE is configured with more than one serving cell and if at least two serving cells have different UL/DL configurations, or for FDD-TDD and primary cell frame structure type 2 and if a serving cell *c* is frame structure type 2,

- if the UE is configured to monitor PDCCH/EPDCCH in another serving cell for scheduling the serving cell , then the UE shall upon detection of a PDSCH transmission within subframe(s)  for serving cell , where  intended for the UE and for which HARQ-ACK response shall be provided, transmit the HARQ-ACK response in UL subframe *n*, wherein set contains values of such that subframe *n-k* corresponds to a DL subframe or a special subframe for serving cell , where  is defined in Table 10.1.3.1-1 (where "UL/DL configuration" in Table 10.1.3.1-1 refers to the "DL-reference UL/DL configuration") is associated with subframe *n.*

- if the UE is not configured to monitor PDCCH/EPDCCH in another serving cell for scheduling the serving cell , then the UE shall upon detection of a PDSCH transmission within subframe(s)  for serving cell , where  intended for the UE and for which HARQ-ACK response shall be provided, transmit the HARQ-ACK response in UL subframe *n*, wherein set contains values of such that subframe *n-k* corresponds to a DL subframe or a special subframe for serving cell , where  is defined in Table 10.1.3A-1 (where "UL/DL configuration" in Table 10.1.3A-1 refers to the "DL-reference UL/DL configuration") is associated with subframe *n.*

For a non-BL/CE UE, and for FDD-TDD and primary cell frame structure type 2, if a serving cell  is frame structure type 1 and a UE is not configured to monitor PDCCH/EPDCCH in another serving cell for scheduling the serving cell , then the UE shall upon detection of a PDSCH transmission within subframe(s)  for serving cell , where , and is defined in Table 10.1.3A-1 intended for the UE and for which HARQ-ACK response shall be provided, transmit the HARQ-ACK response in subframe *n*.

For FDD-TDD and primary cell frame structure type 2, if a serving cell  is frame structure type 1 and a UE is configured to monitor PDCCH/EPDCCH in another serving cell for scheduling serving cell , then the UE shall upon detection of a PDSCH transmission within subframe(s)  for serving cell , where , and is defined in Table 10.1.3.1-1, intended for the UE and for which HARQ-ACK response shall be provided, transmit the HARQ-ACK response in subframe *n*, where "UL/DL configuration" in Table 10.1.3.1-1 refers to the "DL-reference UL/DL configuration" of serving cell .

For TDD, if HARQ-ACK repetition is enabled, upon detection of a PDSCH transmission within subframe(s) , where  and  is defined in Table 10.1.3.1-1 intended for the UE and for which HARQ-ACK response shall be provided, and if the UE is not repeating the transmission of any HARQ-ACK in subframe  corresponding to a PDSCH transmission in a downlink or special subframe earlier than subframe , the UE:

- shall transmit only the HARQ-ACK response (corresponding to the detected PDSCH transmission in subframe) on PUCCH in UL subframe and the next UL subframes denoted as , …,;

- shall not transmit any other signal/channel in UL subframe , , …,; and

- shall not transmit any HARQ-ACK response repetitions corresponding to any detected PDSCH transmission in subframes , where , is the set defined in Table 10.1.3.1-1 corresponding to UL subframe , and .

For TDD, HARQ-ACK bundling, if the UE detects that at least one downlink assignment has been missed as described in Clause 7.3, the UE shall not transmit HARQ-ACK on PUCCH if HARQ-ACK is the only UCI present in a given subframe.

For FDD, a BL/CE UE shall upon detection of a PDSCH intended for the UE and for which an HARQ-ACK shall be provided, transmit the HARQ-ACK response using the same  derived according to Clause 10.1.2.1 in subframe(s) *n+ki* with *i =0,1, …, N-1*, where

- subframe *n-k* is the last subframe in which the PDSCH is transmitted, where

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*

- is given by the 'HARQ-ACK delay' field in the corresponding DCI, and the HARQ-ACK delay value is determined based on the higher layer parameters according to Table 7.3.1-2;

otherwise

-

*- 0≤k0<k1<…,kN-1* and the value of and  is provided by higher layer parameter *pucch-NumRepetitionCE-format1,* if configured, otherwise it is provided by higher layer parameter *pucch-NumRepetitionCE*-*Msg4-Level0-r13, pucch-NumRepetitionCE-Msg4-Level1-r13, pucch-NumRepetitionCE-Msg4-Level2-r13* or *pucch-NumRepetitionCE-Msg4-Level3-r13* depending on whether the most recent PRACH coverage enhancement level for the UE is 0, 1, 2 or 3, respectively; and

if *N>1*

- subframe(s) *n+ki* with *i=0,1,…,N-1* are *N* consecutive BL/CE UL subframe(s) immediately after subframe *n-1*, and the set of BL/CE UL subframes are configured by higher layers;

otherwise

- k0 =0

except if the UE is configured with higher layer parameter *ce-PDSCH-MultiTB-Config* and multiple TB are scheduled in the corresponding DCI.

For FDD, if a BL/CE UE is configured with CEModeA, and if the UE is not configured with higher layer parameter *harq-AckBundling* in *ce-PDSCH-MultiTB-Config* and multiple TB are scheduled in the corresponding DCI, the BL/CE UE shall upon detection of a PDSCH intended for the UE and for which an HARQ-ACK shall be provided, transmit the HARQ-ACK response using the same  derived according to Clause 10.1.2.1 in subframe(s) with , *i =0,1, …, N-1*, where

- is the number of scheduled TB determined in the corresponding DCI;

- if the UE is not configured with higher layer parameter *interleaving* in *ce-PDSCH-MultiTB-Config* and the UE is not in half-duplex FDD operation

- ,

- otherwise

- **,**

- is the last subframe in which the PDSCH containing TB is transmitted;

- subframe is the last subframe in which the PDSCH is transmitted;

- denotes the number of consecutive subframes including non-BL/CE subframes where the PUCCH with HARQ ACK for TB with repetition number of *N* is transmitted;

and

*- 0≤k0<k1<…,kN-1* and the value of and  is provided by higher layer parameter *pucch-NumRepetitionCE-format1,* if configured, otherwise it is provided by higher layer parameter *pucch-NumRepetitionCE*-*Msg4-Level0-r13, pucch-NumRepetitionCE-Msg4-Level1-r13, pucch-NumRepetitionCE-Msg4-Level2-r13* or *pucch-NumRepetitionCE-Msg4-Level3-r13* depending on whether the most recent PRACH coverage enhancement level for the UE is 0, 1, 2 or 3, respectively; and

if *N>1*

- subframe(s) with *i=0,1,…,N-1* for TB are *N* consecutive BL/CE UL subframe(s) immediately after subframe , and the set of BL/CE UL subframes are configured by higher layers;

otherwise

- k0 =0

For FDD, if a BL/CE UE is configured with CEModeA, and if the UE is configured with higher layer parameter *harq-AckBundling* in *ce-PDSCH-MultiTB-Config* and multiple TB are scheduled in the corresponding DCI, the BL/CE UE shall upon detection of a PDSCH intended for the UE and for which an HARQ-ACK shall be provided, transmit the HARQ-ACK response using the same  derived according to Clause 10.1.2.1 in subframe(s) with , *i =0,1, …, N-1*, where

-  is the number of TB bundles, and is determined according to clause 7.3;

- if the UE is not configured with higher layer parameter *interleaving* in *ce-PDSCH-MultiTB-Config* and the UE is not in half-duplex FDD operation

- ,

- otherwise

- subframe **,**

- subframe is the last subframe in which the PDSCH containing TB bundle is transmitted;

- subframe is the last subframe in which the PDSCH is transmitted;

- denotes the number of consecutive subframes including non-BL/CE subframes where the PUCCH with HARQ ACK for TB bundle with repetition number of *N* is transmitted;

and

*- 0≤k0<k1<…,kN-1* and the value of and  is provided by higher layer parameter *pucch-NumRepetitionCE-format1,* if configured, otherwise it is provided by higher layer parameter *pucch-NumRepetitionCE*-*Msg4-Level0-r13, pucch-NumRepetitionCE-Msg4-Level1-r13, pucch-NumRepetitionCE-Msg4-Level2-r13* or *pucch-NumRepetitionCE-Msg4-Level3-r13* depending on whether the most recent PRACH coverage enhancement level for the UE is 0, 1, 2 or 3, respectively; and

if *N>1*

- subframe(s) with *i=0,1,…,N-1* for TB bundle are *N* consecutive BL/CE UL subframe(s) immediately after subframe, and the set of BL/CE UL subframes are configured by higher layers;

otherwise

- k0 =0

For TDD, a BL/CE UE shall upon detection of a PDSCH within subframe(s) , where  and  is defined in Table 10.1.3.1-1 intended for the UE and for which HARQ-ACK response shall be provided, transmit the HARQ-ACK response using the same  derived according to Clause 10.1.3.1 in subframe(s) *n+ki* with *i =0,1, …, N-1*, where

- subframe *n-k* is the last subframe in which the PDSCH is transmitted; and

*- 0≤k0<k1<…,kN-1* and the value of and  is provided by higher layers parameter *pucch-NumRepetitionCE-format1,* if configured, otherwise it is provided by higher layer parameter *pucch-NumRepetitionCE*-*Msg4-Level0-r13, pucch-NumRepetitionCE-Msg4-Level1-r13, pucch-NumRepetitionCE-Msg4-Level2-r13* or *pucch-NumRepetitionCE-Msg4-Level3-r13* depending on whether the most recent PRACH coverage enhancement level for the UE is 0, 1, 2 or 3, respectively; and

if *N>1*

- subframe(s) *n+ki* with *i=0,1,…,N-1* are *N* consecutive BL/CE UL subframe(s) immediately after subframe *n-1*, and the set of BL/CE UL subframes are configured by higher layers;

otherwise

- k0 =0

except if the UE is configured with higher layer parameter *ce-PDSCH-MultiTB-Config* and multiple TB are scheduled in the corresponding DCI.

For TDD, if a BL/CE UE is configured with higher layer parameter *ce-PDSCH-MultiTB-Config* and multiple TBs are scheduled in the corresponding DCI, the BL/CE UE shall upon detection of a PDSCH intended for the UE and for which HARQ-ACK response shall be provided, transmit the HARQ-ACK response using the same  derived according to Clause 10.1.3.1 in subframe(s) *+ki* with , *i =0,1, …, N-1*, where

- is the number of TB bundles

- if the UE is not configured with higher layer parameter *harq-AckBundling* in *ce-PDSCH-MultiTB-Config,* with bundle consisting of only *.*

- Else, the value of and the corresponding TBs in each bundle is determined according to clause 7.3

- is the number of scheduled TB determined in the corresponding DCI;

- ,

- is the last subframe in which the PDSCH containing TB bundle is transmitted;

- denotes the number of consecutive subframes including subframes that are not BL/CE UL subframes where the PUCCH with HARQ ACK for TB bundle with repetition number of *N* is transmitted;

and

*- 0≤k0<k1<…,kN-1* and the value of and  is provided by higher layers parameter *pucch-NumRepetitionCE-format1,* if configured, otherwise it is provided by higher layer parameter *pucch-NumRepetitionCE*-*Msg4-Level0-r13, pucch-NumRepetitionCE-Msg4-Level1-r13, pucch-NumRepetitionCE-Msg4-Level2-r13* or *pucch-NumRepetitionCE-Msg4-Level3-r13* depending on whether the most recent PRACH coverage enhancement level for the UE is 0, 1, 2 or 3, respectively; and

- subframe(s) with *i=0,1,…,N-1* for TB bundle are *N* consecutive BL/CE UL subframe(s) immediately after subframe , and the set of BL/CE UL subframes are configured by higher layers.

The uplink timing for the ACK corresponding to a detected PDCCH/EPDCCH indicating downlink SPS release shall be the same as the uplink timing for the HARQ-ACK corresponding to a detected PDSCH, as defined above.

For a BL/CE UE, the uplink timing for the ACK corresponding to a detected MPDCCH indicating downlink SPS release shall be the same as the uplink timing for the HARQ-ACK corresponding to a detected PDSCH, as defined above.

For a BL/CE UE, if a first HARQ-ACK transmission associated to a first set of PDSCH partially collides with a second HARQ-ACK transmission associated to a second set of PDSCH transmissions, the last PDSCH of the first set of PDSCH transmissions being detected before the last PDSCH of the second set of PDSCH transmissions, the UE shall drop the second HARQ-ACK transmission.

Table 10.2-1: DL-reference UL/DL configuration for serving cell based on pair formed by (primary cell UL/DL configuration, secondary cell UL/DL configuration)

|  |  |  |
| --- | --- | --- |
| Set # | (Primary cell UL/DL configuration,  Secondary cell UL/DL configuration) | DL-reference  UL/DL configuration |
| Set 1 | (0,0) | 0 |
| (1,0),(1,1),(1,6) | 1 |
| (2,0),(2,2),(2,1),(2,6) | 2 |
| (3,0),(3,3),(3,6) | 3 |
| (4,0),(4,1),(4,3),(4,4),(4,6) | 4 |
| (5,0),(5,1),(5,2),(5,3),(5,4),(5,5),(5,6) | 5 |
| (6,0),(6,6) | 6 |
| Set 2 | (0,1),(6,1) | 1 |
| (0,2),(1,2),(6,2) | 2 |
| (0,3),(6,3) | 3 |
| (0,4),(1,4),(3,4),(6,4) | 4 |
| (0,5),(1,5),(2,5),(3,5),(4,5),(6,5) | 5 |
| (0,6) | 6 |
| Set 3 | (3,1),(1,3) | 4 |
| (3,2),(4,2),(2,3),(2,4) | 5 |
| Set 4 | (0,1),(0,2),(0,3),(0,4),(0,5),(0,6) | 0 |
| (1,2),(1,4),(1,5) | 1 |
| (2,5) | 2 |
| (3,4),(3,5) | 3 |
| (4,5) | 4 |
| (6,1),(6,2),(6,3),(6,4),(6,5) | 6 |
| Set 5 | (1,3) | 1 |
| (2,3),(2,4) | 2 |
| (3,1),(3,2) | 3 |
| (4,2) | 4 |

# 11 Physical Multicast Channel (PMCH) related procedures

## 11.1 UE procedure for receiving the PMCH

A UE is not expected to receive PMCH with  (defined in [3]) other than  in an MBSFN subframe with non-zero-size non-MBSFN region.

A UE is not expected to receive PMCH with in an MBSFN subframe with zero-size non-MBSFN region.

The UE shall decode the PMCH when configured by higher layers. The UE may assume that an eNB transmission on the PMCH is performed according to Clause 6.5 of [3].

The for the PMCH is configured by higher layers. To determine the modulation order (****) and TBS index () used in the PMCH the UE shall

- if the UE is configured by higher layers to decode the PMCH based on QPSK, 16QAM, 64QAM, and 256QAM

- if the PMCH is with and the UE is configured with higher layer parameter *timeSeperation* with value '4'

- use and Table 11.1-2 for determining the modulation order (****) and TBS index ()

- otherwise,

- useand Table 7.1.7.1-1A for determining the modulation order (****) and TBS index ()

- otherwise,

- if the PMCH is with and the UE is configured with higher layer parameter *timeSeperation* with value '4'

- use and Table 11.1-1 for determining the modulation order (****) and TBS index ()

- otherwise,

- use and Table 7.1.7.1-1 for determining the modulation order (****) and TBS index ().

The UE shall then follow the procedure in Clause 7.1.7.2.1 to determine the transport block size, assuming is equal to. For PMCH with  the UE shall scale the derived transport block size by , then round to the closest valid transport block size in the union of Table 7.1.7.2.1-1 and Table 7.1.7.2.4-1 by including, in the rounding procedure, only the TBS entries in Table 7.1.7.2.1-1 with and the entries in 7.1.7.2.4-1 for which the TBS\_L1 is present in Table 7.1.7.2.1-1 with if the UE is configured by higher layers to decode the PMCH based on QPSK, 16QAM, 64QAM, and 256QAM; and only the TBS entries in Table 7.1.7.2.1-1 with and the entries in 7.1.7.2.4-1 for which the TBS\_L1 is present in Table 7.1.7.2.1-1 with otherwise. In case the scaled TBS has the same distance to two valid transport block sizes, it is rounded to the larger transport block size. The UE shall set the redundancy version to 0 for the PMCH.

A UE may optionally report parameters *mbms-MaxBW* ()*, mbms-ScalingFactor1dot25* ( , *mbms-ScalingFactor7dot5* (), *mbms-ScalingFactor2dot5* (), and *mbms-ScalingFactor0dot37* () to indicate a limitation on baseband capability provided by the following inequality

where

- *T* is the maximum bandwidth capability of the UE, indicated by *mbms-MaxBW*:

- if mbms-MaxBW is set to implicitValue, then

where the numerator and the denominator correspond to the corresponding columns of the maximum indicated *ue-CategoryDL* in [12].

- if mbms-MaxBW is set to explicitValue, then

- *C* is the number of serving cells the UE is configured with, or receiving PMCH from.

- is the number of spatial layers the UE can receive in the *c*-th serving cell according to *MIMO-CapabilityDL*.

- is the bandwidth (in MHz) of the *c-*th serving cell.

- If the UE is receiving PMCH with 1.25kHz numerology in serving cell *c*, then

-

- else, if the UE is receiving PMCH with 7.5kHz numerology in serving cell *c*, then

-

- else, if the UE is receiving PMCH with 2.5kHz numerology in serving cell *c*, then

-

- else, if the UE is receiving PMCH with 0.37kHz numerology in serving cell *c*, then

-

- else,

-

Table 11.1-1: Modulation and TBS index table for PMCH

|  |  |  |
| --- | --- | --- |
| MCS Index | Modulation Order | TBS Index |
| **0** | 2 | 0 |
| **1** | 2 | 1 |
| **2** | 2 | 2 |
| **3** | 2 | 3 |
| **4** | 2 | 4 |
| **5** | 2 | 5 |
| **6** | 2 | 6 |
| **7** | 2 | 7 |
| **8** | 2 | 8 |
| **9** | 2 | 9 |
| **10** | 2 | 10 |
| **11** | 4 | 10 |
| **12** | 4 | 11 |
| **13** | 4 | 12 |
| **14** | 4 | 13 |
| **15** | 4 | 14 |
| **16** | 4 | 15 |
| **17** | 4 | 16 |
| **18** | 4 | 17 |
| **19** | 4 | 18 |
| **20** | 4 | 19 |
| **21** | 6 | 19 |
| **22** | 6 | 20 |
| **23** | 6 | 21 |
| **24** | 6 | 22 |
| **25** | 6 | 23 |
| **26** | 6 | 24 |
| **27** | 6 | 25 |
| **28** | 6 | 26/26A |
| **29** | 2 | reserved |
| **30** | 4 |
| **31** | 6 |

Table 11.1-2: Modulation and TBS index table 2 for PMCH

| **MCS Index** | **Modulation Order** | **TBS Index** |
| --- | --- | --- |
| **0** | 2 | 0 |
| **1** | 2 | 2 |
| **2** | 2 | 4 |
| **3** | 2 | 6 |
| **4** | 2 | 8 |
| **5** | 2 | 10 |
| **6** | 4 | 11 |
| **7** | 4 | 12 |
| **8** | 4 | 13 |
| **9** | 4 | 14 |
| **10** | 4 | 15 |
| **11** | 4 | 16 |
| **12** | 4 | 17 |
| **13** | 4 | 18 |
| **14** | 4 | 19 |
| **15** | 6 | 20 |
| **16** | 6 | 21 |
| **17** | 6 | 22 |
| **18** | 6 | 23 |
| **19** | 6 | 24 |
| **20** | 6 | 25 |
| **21** | 8 | 27 |
| **22** | 8 | 28 |
| **23** | 8 | 29 |
| **24** | 8 | 30 |
| **25** | 8 | 31 |
| **26** | 8 | 32 |
| **27** | 8 | 33/33A/33B |
| **28** | 2 | reserved |
| **29** | 4 |
| **30** | 6 |
| **31** | 8 |

## 11.2 UE procedure for receiving MCCH and system information change notification

If a UE is configured by higher layers to decode PDCCHs with the CRC scrambled by the M-RNTI, the UE shall decode the PDCCH according to the combination defined in Table 11.2-1.

Table 11.2-1: PDCCH configured by M-RNTI

|  |  |
| --- | --- |
| DCI format | Search Space |
| DCI format 1C | Common |

The 8-bit information for MCCH change notification [11], as signalled on the PDCCH, shall be delivered to higher layers.

The 2-bit information for System information change notification [11], as signalled on the PDCCH, shall be delivered to higher layers.

# 12 Assumptions independent of physical channel

A UE shall not assume that two antenna ports are quasi co-located unless specified otherwise.

A UE may assume the antenna ports 0 – 3 of a serving cell are quasi co-located (as defined in [3]) with respect to delay spread, Doppler spread, Doppler shift, average gain, and average delay.

For the purpose of discovery-signal-based measurements, a UE shall not assume any other signals or physical channels are present other than the discovery signal.

If a UE supports *discoverySignalsInDeactSCell-r12*, and if the UE is configured with discovery-signal-based RRM measurements on a carrier frequency applicable for a secondary cell on the same carrier frequency, and if the secondary cell is deactivated, and if the UE is not configured by higher layers to receive MBMS on the secondary cell, the UE shall, except for discovery-signal transmissions, assume that PSS, SSS, PBCH, CRS, PCFICH, PDSCH, PDCCH, EPDCCH, PHICH, DMRS and CSI-RS may be not transmitted by the secondary cell until the subframe where an activation command is received for the secondary cell.

For BL/CE UE, if CEModeA or CEModeB is not configured, UE shall assume the following configuration:

- For a BL/CE UE with the PRACH coverage enhancement level 0/1, UE shall assume CEModeA.

- For a BL/CE UE with the PRACH coverage enhancement level 2/3, UE shall assume CEModeB.

If a UE is configured by higher layers to operate in an MBMS-dedicated serving cell, or if a UE is configured by higher layers to operate in an FeMBMS/Unicast-mixed serving cell and is configured with a carrier indicator field in the FeMBMS/Unicast-mixed serving cell,

- the UE shall assume that physical signals or physical channels may not be transmitted by the serving cell in a non-zero-size non-MBSFN region of an MBSFN subframe not assumed to be used for PMCH, regardless of whether there is any physical signal or physical channel being transmitted in the MBSFN region of such an MBSFN subframe.

If a UE is not configured with a carrier indicator field on a serving cell, the UE can assume that physical signals and physical channels are present in a non-zero-size non-MBSFN region of an MBSFN subframe on the serving cell.

# 13 Uplink/Downlink configuration determination procedure for Frame Structure Type 2

If the 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.

For each serving cell

If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12*,

- the UE shall set the UL/DL configuration equal to the UL/DL configuration (i.e., the parameter *subframeAssignment*) indicated by higher layers.

If the UE is configured by higher layers with the parameter *EIMTA-MainConfigServCell-r12*, then for each radio frame,

- the UE shall determine eIMTA-UL/DL-configuration as described in Clause 13.1.

- the UE shall set the UL/DL configuration for each radio frame equal to the eIMTA-UL/DL-configuration of that radio frame.

- For a serving cell , a UE is not expected to be configured with parameter *harq-ReferenceConfig-r14* if a subframe indicated as an uplink subframe by *harq-ReferenceConfig-r14* is not indicated as an uplink subframe by the UL-reference UL/DL configuration if it is configured, otherwise, indicated as uplink subframe by UL/DL configuration*.*

## 13.1 UE procedure for determining eIMTA-uplink/downlink configuration

If a UE is configured by higher layers to decode PDCCHs with the CRC scrambled by the eIMTA-RNTI, the UE shall decode the PDCCH according to the combination defined in Table 13.1-1.

Table 13.1-1: PDCCH configured by eIMTA-RNTI

|  |  |
| --- | --- |
| **DCI format** | **Search Space** |
| DCI format 1C | Common |

The subframes in which the UE monitors PDCCH with CRC scrambled by eIMTA-RNTI are configured by higher layers.

For each serving cell,

- if *T*= 10,

- if the UE detects PDCCH with CRC scrambled by eIMTA-RNTI in subframe 0 of a radio frame *m* or if the UE detects PDCCH with CRC scrambled by eIMTA-RNTI in a subframe other than subframe 0 of a radio frame *m*-1,

- the eIMTA-UL/DL-configuration for radio frame *m* is given by the UL/DL configuration indication signalled on the PDCCH as described in [4],

- the UE may assume that the same UL/DL configuration indication is indicated by PDCCH with CRC scrambled by eIMTA-RNTI in subframe 0 of radio frame *m* and in all the subframes other than subframe 0 of radio frame *m*-1 in which PDCCH with CRC scrambled by eIMTA-RNTI is monitored,

- otherwise

- the eIMTA-UL/DL-configuration for radio frame *m* is same as the UL/DL configuration (i.e., the parameter *subframeAssignment*) indicated by higher layers;

- if *T* is a value other than 10,

- if the UE detects PDCCH with CRC scrambled by eIMTA-RNTI in a subframe in radio frame *mT*/10,

- the eIMTA-UL/DL-configuration for radio frames {*mT*/10+1 , *mT*/10+2,…. (*m* + 1)*T*/10} is given by the UL/DL configuration indication signalled on the PDCCH as described [4],

- the UE may assume that the same UL/DL configuration indication is indicated by PDCCH with CRC scrambled by eIMTA-RNTI in all the subframes of radio frame *mT*/10in which PDCCH with CRC scrambled by eIMTA-RNTI is monitored,

- otherwise

- the eIMTA-UL/DL-configuration for radio frames {*mT*/10+1 , *mT*/10+2,…. (*m* +1) *T*/10} is same as the UL/DL configuration (i.e., the parameter *subframeAssignment*) indicated by higher layers.

where *T* denotes the value of parameter *eimta-CommandPeriodicity-r12*.

For a serving cell , if subframe *i* is indicated as uplink subframe or a special subframe by higher layer parameter *eimta-HARQ-ReferenceConfig-r12*, the UE is not expected to receive a PDCCH with CRC scrambled by eIMTA-RNTI containing an UL/DL configuration for serving cell  that would indicate subframe *i* as a downlink subframe.

For a serving cell , if subframe *i* is indicated as downlink subframe or a special subframe by higher layer parameter *subframeAssignment*, the UE is not expected to receive a PDCCH with CRC scrambled by eIMTA-RNTI containing an UL/DL configuration for serving cell  that would indicate subframe *i* as an uplink subframe.

For a serving cell , a UE is not expected to be configured with parameter *eimta-HARQ-ReferenceConfig-r12* if a subframe indicated as an uplink subframe by *eimta-HARQ-ReferenceConfig-r12* is not indicated as an uplink subframe by the UL-reference UL/DL configuration.

If UE is not configured with the parameter *EIMTA-MainConfigServCell-r12* for any activated serving cell, the UE is not expected to monitor PDCCH with CRC scrambled by eIMTA-RNTI.

If the UE is configured with the parameter *EIMTA-MainConfigServCell-r12* for at least one serving cell, the UE is not expected to monitor PDCCH with CRC scrambled by eIMTA-RNTI outside of the Active Time defined in [8] in order to determine the configured CSI-RS or CSI-IM REs in subframe 6 for CSI reporting purposes. If the UE doesn't detect an UL/DL configuration indication for radio frame *m,* the UE determines the configured CSI-RS and CSI-IM REs in subframe 6 according to the UL/DL configuration indicated by higher layer parameter *subframeAssignment* for the serving cell.

# 13A Subframe configuration for Frame Structure Type 3

If a UE detects PDCCH with DCI CRC scrambled by CC-RNTI in subframe n-1 or subframe n of a LAA Scell, the UE may assume the configuration of occupied OFDM symbols in subframe n of the LAA Scell according to the 'Subframe configuration for LAA' field in the detected DCI in subframe n-1 or subframe n.

The 'Subframe configuration for LAA' field indicates the configuration of occupied OFDM symbols (i.e., OFDM symbols used for transmission of downlink physical channels and/or physical signals) in current and/or next subframe according to Table 13A-1.

If the configuration of occupied OFDM symbols for subframe n is indicated by the Subframe configuration for LAA field in both subframe n-1 and subframe n, the UE may assume that the same configuration of occupied OFDM symbols is indicated in both subframe n-1 and subframe n.

If a UE detects PDCCH with DCI CRC scrambled by CC-RNTI in subframe n, and the UE does not detect PDCCH with DCI CRC scrambled by CC-RNTI in subframe n-1, and if the number of occupied OFDM symbols for subframe n indicated by the Subframe configuration for LAA field in subframe n is less than 14, the UE is not required to receive any other physical channels in subframe n except for PDCCH with DCI format 0A/0B/4A/4B if configured.

If a UE does not detect PDCCH with DCI CRC scrambled by CC-RNTI containing 'Subframe Configuration for LAA' field set to other than '1110' and '1111' in subframe n and the UE does not detect PDCCH with DCI CRC scrambled by CC-RNTI containing 'Subframe Configuration for LAA' field set to other than '1110' and '1111' in subframe n-1, the UE is not required to use subframe n for updating CSI measurement.

The UE may detect PDCCH with DCI CRC scrambled by CC-RNTI by monitoring the following PDCCH candidates according to DCI Format 1C.

- one PDCCH candidate at aggregation level L=4 with the CCEs corresponding to the PDCCH candidate given by CCEs numbered 0,1,2,3

- one PDCCH candidate at aggregation level L=8 with the CCEs corresponding to the PDCCH candidate given by CCEs numbered 0,1,2,3,4,5,6,7

If a serving cell is a LAA Scell, and if the higher layer parameter *subframeStartPosition* for the Scell indicates 's07', and if the UE detects PDCCH/EPDCCH intended for the UE starting in the second slot of a subframe, the UE may assume that OFDM symbols in the first slot of the subframe are not occupied, and all OFDM symbols in the second slot of the subframe are occupied,

If subframe n is a subframe in which OFDM symbols in the first slot are not occupied, the UE may assume that all the OFDM symbols are occupied in subframe n+1.

Table 13A-1: Subframe configuration for LAA in current and next subframe

|  |  |
| --- | --- |
| Value of  'Subframe configuration for LAA' field in current subframe | Configuration of occupied OFDM symbols  (current subframe, next subframe) |
| 0000 | (-,14) |
| 0001 | (-,12) |
| 0010 | (-,11) |
| 0011 | (-,10) |
| 0100 | (-,9) |
| 0101 | (-,6) |
| 0110 | (-,3) |
| 0111 | (14,\*) |
| 1000 | (12,-) |
| 1001 | (11,-) |
| 1010 | (10,-) |
| 1011 | (9,-) |
| 1100 | (6,-) |
| 1101 | (3,-) |
| 1110 | reserved |
| 1111 | reserved |
| NOTE:  - (-, Y) means UE may assume the first Y symbols are occupied in next subframe and other symbols in the next subframe are not occupied.  - (X, -) means UE may assume the first X symbols are occupied in current subframe and other symbols in the current subframe are not occupied.  - (X, \*) means UE may assume the first X symbols are occupied in current subframe, and at least the first OFDM symbol of the next subframe is not occupied. | |

If a UE is configured with a LAA SCell for UL transmissions, and the UE detects PDCCH with DCI CRC scrambled by CC-RNTI in subframe *n*, the UE may be configured with a 'UL duration' and 'UL offset' for subframe *n* according to the 'UL duration and offset' field in the detected DCI. The 'UL duration and offset' field indicates the 'UL duration' and 'UL offset' according to Table 13A-2.

If the 'UL duration and offset' field configures an 'UL offset'  and an 'UL duration' for subframe *n*, the UE is not required to receive any downlink physical channels and/or physical signals in subframe(s) *n+l+ i* with *i =* 0, 1, …, *d*-1.

Table 13A-2: UL duration and offset.

|  |  |  |
| --- | --- | --- |
| Value of  'UL duration and offset' field | UL offset,  (in subframes) | UL duration, (in subframes) |
| 00000 | Not configured | Not configured |
| 00001 | 1 | 1 |
| 00010 | 1 | 2 |
| 00011 | 1 | 3 |
| 00100 | 1 | 4 |
| 00101 | 1 | 5 |
| 00110 | 1 | 6 |
| 00111 | 2 | 1 |
| 01000 | 2 | 2 |
| 01001 | 2 | 3 |
| 01010 | 2 | 4 |
| 01011 | 2 | 5 |
| 01100 | 2 | 6 |
| 01101 | 3 | 1 |
| 01110 | 3 | 2 |
| 01111 | 3 | 3 |
| 10000 | 3 | 4 |
| 10001 | 3 | 5 |
| 10010 | 3 | 6 |
| 10011 | 4 | 1 |
| 10100 | 4 | 2 |
| 10101 | 4 | 3 |
| 10110 | 4 | 4 |
| 10111 | 4 | 5 |
| 11000 | 4 | 6 |
| 11001 | 6 | 1 |
| 11010 | 6 | 2 |
| 11011 | 6 | 3 |
| 11100 | 6 | 4 |
| 11101 | 6 | 5 |
| 11110 | 6 | 6 |
| 11111 | reserved | reserved |