10 Physical uplink control channel procedures

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.

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 n uplink control information (UCI) shall be transmitted

- on PUCCH using format 1/1a/1b/3 or 2/2a/2b if the UE is not transmitting PUSCH
- on PUSCH if the UE is transmitting PUSCH in subframe n 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 for a single serving cell and simultaneous PUSCH and PUCCH transmission, then in subframe n UCI shall be transmitted

- on PUCCH using format 1/1a/1b/3 if the UCI consists only of HARQ-ACK and/or SR
- 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 n, in which case the HARQ-ACK/HARQ-ACK+SR/positive SR is transmitted on PUCCH using format 1/1a/1b/3 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

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

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

- on PUSCH of the serving cell given in Subclause 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 n 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 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 n UCI shall be transmitted

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

- on 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 Subclause 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 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 PUCCH using format 1/1a/1b/3 and the aperiodic CSI is transmitted on PUSCH of the serving cell given in Subclause 7.2.1

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

- 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 n , or if the UE is transmitting PUSCH in subframe n 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 n and the indicated PUSCH repetition number in DCI format 6-0A/6-0B is larger than 1

- 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 n , or if the UE is transmitting PUSCH in subframe n 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 n and the indicated PUSCH repetition number in DCI format 6-0A/6-0B is larger than 1

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

- on PUSCH if the UE is transmitting PUSCH in subframe n and the number of PUCCH repetitions defined for the UCI in [3] is equal to 1, and the indicated PUSCH repetition number in DCI format 6-0A/6-0B is equal to 1 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 Subclause 7.2.2.

A UE transmits PUCCH only on the primary cell.

A UE is configured by higher layers to transmit PUCCH on one antenna port $(p = p_0)$ or two antenna ports $(p \in [p_0, p_1])$. PUCCH format 4 and PUCCH format 5 can only be transmitted on one antenna port $(p = p_0)$.

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 two or more configured serving cells and PUCCH format 3 and without PUCCH format 4/5 configured, $n_{\text{HARQ}} = \sum_{c=0}^{N_{cells}^{DL}-1} N_c^{\text{received}}$ where N_{cells}^{DL} is the number of configured cells and N_c^{received} is the number of transport blocks or the SPS release PDCCH/EPDCCH, if any, received in subframe $n-4$ in serving cell c.

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, $n_{\text{HARQ}} = \sum_{c=0}^{N_{cells}^{DL}-1} \sum_{k \in K} N_{k,c}^{\text{received}}$, where $N_{k,c}^{\text{received}}$ is the number of transport blocks or the SPS release PDCCH/EPDCCH, if any, received in subframe $n-k$ in serving cell c, where $k \in K$, 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, $n_{\text{HARQ}} = \sum_{c=0}^{N_{cells}^{DL}-1} \left(\left(V_{\text{DAI},c}^{\text{DL}} - U_{\text{DAI},c} \right) \bmod 4 \right) \cdot n_c^{\text{ACK}} + \sum_{k \in K} N_{k,c}^{\text{received}} \right)$ where $V_{\text{DAI,c}}^{\text{DL}}$ is the $V_{\text{DAI}}^{\text{DL}}$ in serving cell c, $U_{\text{DAI,c}}$ is the U_{DAI} in serving cell c, and n_c^{ACK} is the number of HARQ-ACK bits corresponding to the configured DL transmission mode on serving cell c. In case spatial HARQ-ACK bundling is applied, $n_c^{\text{ACK}} = 1$ and $N_{k,c}^{\text{received}}$ is the number of PDCCH/EPDCCH or PDSCH without a corresponding PDCCH/EPDCCH received in subframe $n-k$ and serving cell c, where $k \in K$ and *M* is the number of elements in *K*. In case spatial HARQ-ACK bundling is not applied, $N_{k,c}^{\text{received}}$ is the number of transport blocks received or the SPS release PDCCH/EPDCCH received in subframe $n-k$ in serving cell c, where $k \in K$ and *M* is the number of elements in *K*. $V_{\text{DAI,c}}^{\text{DL}}$ =0 if no transport block or SPS release PDCCH/EPDCCH is detected in subframe(s) $n-k$ in serving cell c, where $k \in K$.
- For TDD with two configured serving cells and PUCCH format 1b with channel selection and *M* = 3 or 4, $n_{\text{HARQ}} = 2$ if UE receives PDSCH or PDCCH/EPDCCH indicating downlink SPS release only on one serving cell within subframes $n-k$,where $k \in K$;otherwise $n_{\text{HARQ}} = 4$.

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 $M \le 2$ (defined in Subclause 10.1.3.2.1 for TDD and Subclause 10.1.3A for FDD-TDD), $n_{\text{HARQ}} = \sum_{c=0}^{N_{cells}^{DL}-1} \left(\left(V_{\text{DAI},c}^{\text{DL}} - U_{\text{DAI},c} \right) \bmod 4 \right) \cdot n_c^{\text{ACK}} + \sum_{k \in K} N_{k,c}^{\text{received}} \right)$ where $V_{\text{DAI,c}}^{\text{DL}}$ is the $V_{\text{DAI}}^{\text{DL}}$ in serving cell c, $U_{\text{DAI,c}}$ is the U_{DAI} in serving cell c, and n_c^{ACK} is the number of HARQ-ACK bits corresponding to the configured DL transmission mode on serving cell c. In case spatial HARQ-ACK bundling is applied, $n_c^{\text{ACK}} = 1$ and $N_{k,c}^{\text{received}}$ is the number of PDCCH/EPDCCH or PDSCH without a corresponding PDCCH/EPDCCH received in subframe $n-k$ and serving cell c, where $k \in K$ and $K = K_c$

(defined in Subclause 7.3.2.2 for TDD and Subclause 7.3.4 for FDD-TDD). In case spatial HARQ-ACK bundling is not applied, $N_{k,c}^{\text{received}}$ is the number of transport blocks received or the SPS release PDCCH/EPDCCH received in subframe $n-k$ in serving cell c, where $k \in K$ and $K = K_c$ (defined in Subclause 7.3.2.2 for TDD and Subclause 7.3.4 for FDD-TDD). $V_{\text{DAI, c}}^{\text{DL}}$ =0 if no transport block or SPS release PDCCH/EPDCCH is detected in subframe(s) $n-k$ in serving cell c, where $k \in K$ and $K = K_c$ (defined in Subclause 7.3.2.2 for TDD and Subclause 7.3.4 for FDD-TDD). For a serving cell c, set $V_{\text{DAI, c}}^{\text{DL}} = U_{\text{DAI, c}}$ if the DL-reference UL/DL configuration (defined in Subclause 10.2) for serving cell c 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 Subclause 10.1.3.2.1 for TDD and Subclause 10.1.3A for FDD-TDD), $n_{\text{HARQ}} = 2$ if UE receives PDSCH or PDCCH/EPDCCH indicating downlink SPS release only on one serving cell within subframes $n-k$,where $k \in K$ and $K = K_c$ (defined in Subclause 7.3.2.2 for TDD and Subclause 7.3.4 for FDD-TDD); otherwise $n_{\text{HARQ}} = 4$.

Throughout the following Subclauses, subframes are numbered in monotonically increasing order; if the last subframe of a radio frame is denoted as k , the first subframe of the next radio frame is denoted as $k+1$.

Throughout the following Subclauses for a non-BL/CE UE, if the UE is configured with higher layer parameter *n1PUCCH-AN-r11* then $N_{\text{PUCCH}}^{(1)}$ is given by *n1PUCCH-AN-r11*, else $N_{\text{PUCCH}}^{(1)}$ is given by higher layer parameter *n1PUCCH-AN* .

10.1.1 PUCCH format information

Using the PUCCH formats defined in Subclause 5.4.1 and 5.4.2 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.
- 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.
- 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.
- Format 3 for HARQ-ACK, 1-bit positive/negative SR (if any) and CSI report(s).
- 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.
- Format 4 for more than 22 bits of UCI including HARQ-ACK, SR (if any) and periodic CSI report(s) (if any).

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

- 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 indicating downlink SPS release is detected in a subframe 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 a serving cell configured with a transmission mode supporting one transport blockis 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 Subclause 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 Subclause 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 Subclause 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 Subclause 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 Subclause 10.1.2.2.3 and there is no PUCCH format 3 or 5 determined to transmit the HARQ-ACK/SR according to Subclause 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 $n_{\mathrm{PUCCH}}^{(4)}$ according to higher layer parameter *format4-MultiCSI-resourceConfiguration*, the PUCCH format 4 resource $n_{\mathrm{PUCCH}}^{(4)}$ 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 $n_{\mathrm{PUCCH}}^{(5)}$ according to higher layer parameter *format5-MultiCSI-resourceConfiguration*, the PUCCH format 5 resource $n_{\mathrm{PUCCH}}^{(5)}$ 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 $n_{\mathrm{PUCCH},1}^{(4)}$ and $n_{\mathrm{PUCCH},2}^{(4)}$ according to higher layer parameter *format4-MultiCSI-resourceConfiguration*, if $\left(O^{ACK}+O^{SR}+O_{\mathrm{P-CSI}}+O_{\mathrm{CRC}}\right)\le \min\left(M_{\mathrm{RB},1}^{\mathrm{PUCCH4}}, M_{\mathrm{RB},2}^{\mathrm{PUCCH4}}\right)\cdot N_{sc}^{RB}\cdot N_{\mathrm{symb}}^{\mathrm{PUCCH4}}\cdot 2\cdot r$, the PUCCH format 4 resource with the smaller $M_{\mathrm{RB},i}^{\mathrm{PUCCH4}}$ between $n_{\mathrm{PUCCH},1}^{(4)}$ and $n_{\mathrm{PUCCH},2}^{(4)}$ is used for transmission of the HARQ-ACK/SR and periodic CSI report(s); otherwise, the PUCCH format 4 resource with the larger $M_{\mathrm{RB},i}^{\mathrm{PUCCH4}}$ between $n_{\mathrm{PUCCH},1}^{(4)}$ and $n_{\mathrm{PUCCH},2}^{(4)}$ is used for transmission of the HARQ-ACK/SR and periodic CSI report(s), where

- O^{ACK} is the total number of HARQ-ACK bits in the subframe;
- $O^{SR} = 0$ if there no scheduling request bit in the subframe and $O^{SR} = 1$ otherwise
- $O_{\text{P-CSI}}$ is the total number of CSI report bits in the subframe;
- O_{CRC} is the number of CRC bits;
- $M_{\text{RB},i}^{\text{PUCCH4}}$, $i = 1,2$, is the number of PRBs for $n_{\text{PUCCH},1}^{(4)}$ and $n_{\text{PUCCH},2}^{(4)}$ respectively, according to higher layer parameter *numberOfPRB-format4-r13* according to Table 10.1.1-2;
- $N_{\text{symb}}^{\text{PUCCH4}} = 2 \cdot \left(N_{\text{symb}}^{\text{UL}} - 1\right) - 1$ if shortened PUCCH format 4 is used in the subframe and $N_{\text{symb}}^{\text{PUCCH4}} = 2 \cdot \left(N_{\text{symb}}^{\text{UL}} - 1\right)$ otherwise; and
- r is the code rate given by higher layer parameter *maximumPayloadCoderate-r13* according to Table 10.1.1-2*;*

- 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 Subclause 10.1.2.2.3 and there is no PUCCH format 3 or 5 determined to transmit the HARQ-ACK/SR according to Subclause 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 Subclause 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 $n_{\text{PUCCH}}^{(4)}$ or PUCCH format 5 $n_{\text{PUCCH}}^{(5)}$ in a subframe
  - if $\left(O^{ACK} + O^{SR} + O_{\text{P-CSI}} + O_{\text{CRC}}\right) \le 2 \cdot N_{\text{RE}} \cdot r$, the UE shall transmit the HARQ-ACK/SR and periodic CSI bits using the PUCCH format 4 $n_{\text{PUCCH}}^{(4)}$ or the PUCCH format 5 $n_{\text{PUCCH}}^{(5)}$;
  - if $\left(O^{ACK} + O^{SR} + O_{\text{P-CSI}} + O_{\text{CRC}}\right) > 2 \cdot N_{\text{RE}} \cdot r$, the UE shall select $N_{\text{CSI,reported}}$ CSI report(s) for transmission together with HARQ-ACK/SR in ascending order of $\text{Pri}_{CSI}(y,s,c,t)$, where $\text{Pri}_{CSI}(y,s,c,t)$, N_{RE} and r are determined according to Subclause 7.2.2; the value of $N_{\text{CSI,reported}}$ satisfies $\left(O^{ACK} + O^{SR} + \sum_{n=1}^{N_{\text{CSI,reported}}} O_{\text{P-CSI},n} + O_{\text{CRC}}\right) \le 2 \cdot N_{\text{RE}} \cdot r$ and $\left(O^{ACK} + O^{SR} + \sum_{n=1}^{N_{\text{CSI,reported}}+1} O_{\text{P-CSI},n} + O_{\text{CRC}}\right) > 2 \cdot N_{\text{RE}} \cdot r$, and $O_{P-CSI,n}$ is the number of CSI report bits for the *n*th CSI report in ascending order of $\text{Pri}_{CSI}(y,s,c,t)$.

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* or if the parameter *simultaneousAckNackAndCQI-Format3-r11* provided by higher layers is set *TRUE* or if 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 Subclause 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, 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 $n-k \geq 4$, 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 each of the serving cells configured for the UE has frame structure type 1, UE procedures for HARQ-ACK feedback are given in Subclause 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 Subclause 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 Subclause 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 Subclause 10.1.3A.

Table 10.1.1-1: code rate r corresponding to higher layer parameter *maximumPayloadCoderate-r13*

Value of *maximumPayloadCoderate-r13*	Code rate r
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 M_{RB}^{PUCCH4} corresponding to higher layer parameter *numberOfPRB-format4-r13*

Value of *numberOfPRB-format4-r13*	M_{RB}^{PUCCH4}

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.
- For calculating the HARQ-ACK bits to be transmitted, the UE shall follow the procedure in subclauses 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, O, 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.

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 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 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 Subclause 10.1.2.1 and procedures for more than one configured serving cell are given in Subclause 10.1.2.2.

10.1.2.1 FDD HARQ-ACK procedure for one configured serving cell

HARQ-ACK transmission on two antenna ports ($p \in [p_0, p_1]$) is supported for PUCCH format 1a/1b.

For FDD and one configured serving cell, the UE shall use PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p})}$ for transmission of HARQ-ACK in subframe n for $\tilde{p}$ 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 $n-4$, or for a PDCCH indicating downlink SPS release (defined in Subclause 9.2) in subframe $n-4$, the UE shall use $n_{\text{PUCCH}}^{(1,\tilde{p}_0)} = n_{\text{CCE}} + N_{\text{PUCCH}}^{(1)}$ for antenna port p_0, where n_{CCE} 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 $N_{\text{PUCCH}}^{(1)}$ is configured by higher layers. For two antenna port transmission the PUCCH resource for antenna port p_1 is given by $n_{\text{PUCCH}}^{(1,\tilde{p}_1)} = n_{\text{CCE}} + 1 + N_{\text{PUCCH}}^{(1)}$.
- 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 $n-4$, the value of $n_{\text{PUCCH}}^{(1,\tilde{p})}$ 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 $n_{\text{PUCCH}}^{(1,\tilde{p}_0)}$ for antenna port p_0 and the second PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p}_1)}$ for antenna port p_1, otherwise, the PUCCH resource value maps to a single PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p}_0)}$ for antenna port p_0.

- for a PDSCH transmission indicated by the detection of a corresponding EPDCCH in subframe $n-4$, or for an EPDCCH indicating downlink SPS release (defined in Subclause 9.2) in subframe $n-4$, the UE shall use
  - if EPDCCH-PRB-set q is configured for distributed transmission
    $n_{\mathrm{PUCCH}}^{(1,\tilde{p}_0)} = n_{\mathrm{ECCE,q}} + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$
  - if EPDCCH-PRB-set q is configured for localized transmission
    $n_{\mathrm{PUCCH}}^{(1,\tilde{p}_0)} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + n' + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$

  for antenna port p_0, where $n_{\mathrm{ECCE,q}}$ 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 q, Δ_{ARO} 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, $N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$ for EPDCCH-PRB-set q is configured by the higher layer parameter *pucch-ResourceStartOffset-r11* , $N_{RB}^{ECCE,q}$ for EPDCCH-PRB-set q is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for localized EPDCCH transmission which is described in Subclause 6.8A.5 in [3]. For two antenna port transmission the PUCCH resource for antenna port p_1 is given by
  - if EPDCCH-PRB-set q is configured for distributed transmission
    $n_{\mathrm{PUCCH}}^{(1,\tilde{p}_1)} = n_{\mathrm{ECCE,q}} + 1 + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$
  - if EPDCCH-PRB-set q is configured for localized transmission
    $n_{\mathrm{PUCCH}}^{(1,\tilde{p}_1)} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + 1 + n' + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$
- for a BL/CE UE, and for a PDSCH on the primary cell where there is not a corresponding MPDCCH detected and subframe $n-k$ is the last subframe in which the PDSCH is transmitted, the value of $n_{\mathrm{PUCCH}}^{(1,\mathrm{p}_0)}$ 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 Subclause 9.2) where subframe $n-k$ is the last subframe in which the PDSCH is transmitted, or for HD-FDD HARQ-ACK bundling, subframe $n-k$ is the last subframe in which the PDSCH is detected, the UE shall use
  - if MPDCCH-PRB-set q is configured for distributed transmission
    $n_{\mathrm{PUCCH}}^{(1,\mathrm{p}_0)} = n_{\mathrm{ECCE,q}} + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(m1)}$
  - if MPDCCH-PRB-set q is configured for localized transmission
    $n_{\mathrm{PUCCH}}^{(1,\mathrm{p}_0)} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + n' + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(m1)}$

  for antenna port p_0, where $n_{\mathrm{ECCE,q}}$ 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 q, or for HD-FDD HARQ-ACK bundling $n_{\mathrm{ECCE,q}}$ 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 q, Δ_{ARO} 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, $N_{\mathrm{PUCCH,q}}^{(m1)}$ for MPDCCH-PRB-set q 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,

$N_{RB}^{ECCE,q}$ for MPDCCH-PRB-set q is given in Subclause 6.8A.1 in [3] where the same $N_{RB}^{ECCE,q}$ value is used for each subframe containing a repeat of a MPDCCH transmission, n' is determined from the antenna port used for localized MPDCCH transmission which is described in Subclause 6.8A.5 in [3]. When an MPDCCH-PRB-set p is 2+4, following procedures is applied.

- if the detected MPDCCH is located within 2 PRB set, $n_{\mathrm{PUCCH}}^{(1,\mathrm{p}_0)}$ is obtained by above procedure.
- if the detected MPDCCH is located within 4 PRB set, $n_{\mathrm{PUCCH}}^{(1,\mathrm{p}_0)}$ is the sum between $2N_{RB}^{ECCE,q}$ and the value obtained by above procedure.
- if the detected MPDCCH is MPDCCH format 5, $n_{\mathrm{PUCCH}}^{(1,\mathrm{p}_0)}$ is obtained by the above procedure with $n_{\mathrm{ECCE,q}} = 0$.

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 Δ_{ARO} values

ACK/NACK Resource offset field in DCI format 1A/1B/1D/1/2A/2/2B/2C/2D	Δ_{ARO}
0	0
1	-1
2	-2
3	2

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 Subclause 10.1.2.2.1 or a PUCCH format 3 HARQ-ACK procedure as described in Subclause 10.1.2.2.2 or a PUCCH format 4 HARQ-ACK procedure as described in Subclause 10.1.2.2.3 or a PUCCH format 5 HARQ-ACK procedure as described in Subclause 10.1.2.2.4.

HARQ-ACK transmission on two antenna ports $(p \in [p_0, p_1])$ is supported for PUCCH format 3.

HARQ-ACK transmission on two antenna ports $(p \in [p_0, p_1])$ 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 $b(0)b(1)$ on PUCCH resource $n_{\mathrm{PUCCH}}^{(1,\tilde{p})}$ for $\tilde{p}$ mapped to antenna port p using PUCCH format 1b where

- $n_{\mathrm{PUCCH}}^{(1,\tilde{p}_0)} = n_{\mathrm{PUCCH}}^{(1)}$ for antenna port p_0 where $n_{\mathrm{PUCCH}}^{(1)}$ is selected from A PUCCH resources, $n_{\mathrm{PUCCH},j}^{(1)}$ where $0 \le j \le A-1$ and $A \in \{2,3,4\}$, 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 n. HARQ-ACK(j) denotes the ACK/NACK/DTX response for a transport block or SPS release PDCCH/EPDCCH associated with serving cell c, where the transport block and serving cell for HARQ-ACK(j) and A PUCCH resources are given by Table 10.1.2.2.1-1.
- $n_{\mathrm{PUCCH}}^{(1,\tilde{p}_1)}$ for antenna port p_1, where $n_{\mathrm{PUCCH}}^{(1,\tilde{p}_1)}$ is selected from A PUCCH resources, $n_{\mathrm{PUCCH},j}^{(1,\tilde{p}_1)}$ configured by higher layers where $0 \le j \le A-1$ and $A \in \{2,3,4\}$, 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 $n_{\text{PUCCH}}^{(1)}$ with $n_{\text{PUCCH}}^{(1,\tilde{p}_1)}$ and replacing $n_{\text{PUCCH},i}^{(1)}$ with $n_{\text{PUCCH},i}^{(1,\tilde{p}_1)}$ in subframe n, 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, c, 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 c.

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 A PUCCH resources, $n_{\text{PUCCH},j}^{(1)}$ associated with HARQ-ACK(j) where $0 \le j \le A-1$ in Table 10.1.2.2.1-1, according to

- for a PDSCH transmission indicated by the detection of a corresponding PDCCH in subframe $n-4$ on the primary cell, or for a PDCCH indicating downlink SPS release (defined in Subclause 9.2) in subframe $n-4$ on the primary cell, the PUCCH resource is $n_{\text{PUCCH,j}}^{(1)} = n_{\text{CCE}} + N_{\text{PUCCH}}^{(1)}$, and for transmission mode that supports up to two transport blocks, the PUCCH resource $n_{\text{PUCCH},j+1}^{(1)}$ is given by $n_{\text{PUCCH},j+1}^{(1)} = n_{\text{CCE}} + 1 + N_{\text{PUCCH}}^{(1)}$ where n_{CCE} is the number of the first CCE used for transmission of the corresponding PDCCH and $N_{\text{PUCCH}}^{(1)}$ is configured by higher layers.
- for a PDSCH transmission on the primary cell where there is not a corresponding PDCCH/EPDCCH detected in subframe $n-4$, the value of $n_{\text{PUCCH},j}^{(1)}$ 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 $n_{\text{PUCCH},j+1}^{(1)}$ is given by $n_{\text{PUCCH},j+1}^{(1)} = n_{\text{PUCCH},j}^{(1)} + 1$
- for a PDSCH transmission indicated by the detection of a corresponding PDCCH/EPDCCH in subframe $n-4$ on the secondary cell, the value of $n_{\text{PUCCH},j}^{(1)}$, and the value of $n_{\text{PUCCH},j+1}^{(1)}$ 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 $(n_{\text{PUCCH},j}^{(1)}, n_{\text{PUCCH},j+1}^{(1)})$, otherwise, the PUCCH resource value maps to a single PUCCH resource $n_{\text{PUCCH},j}^{(1)}$.
- for a PDSCH transmission indicated by the detection of a corresponding EPDCCH in subframe $n-4$ on the primary cell, or for an EPDCCH indicating downlink SPS release (defined in Subclause 9.2) in subframe $n-4$ on the primary cell, the PUCCH resource is given by
  - if EPDCCH-PRB-set q is configured for distributed transmission

    $$n_{\text{PUCCH,j}}^{(1)} = n_{\text{ECCE,q}} + \Delta_{ARO} + N_{\text{PUCCH,q}}^{(\text{e1})}$$

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

$$n_{\mathrm{PUCCH,j}}^{(1)} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + n' + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(e1)}$$

where $n_{\mathrm{ECCE,q}}$ 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 q, Δ_{ARO} 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, $N_{\mathrm{PUCCH,q}}^{(e1)}$ for EPDCCH-PRB-set q is configured by the higher layer parameter *pucch-ResourceStartOffset-r11*, $N_{RB}^{ECCE,q}$ for EPDCCH-PRB-set q is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for localized EPDCCH transmission which is described in Subclause 6.8A.5 in [3].

For transmission mode that supports up to two transport blocks, the PUCCH resource $n_{\mathrm{PUCCH},j+1}^{(1)}$ is given by

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

$$n_{\mathrm{PUCCH,j+1}}^{(1)} = n_{\mathrm{ECCE,q}} + 1 + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(e1)}$$

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

$$n_{\mathrm{PUCCH,j+1}}^{(1)} = \left\lfloor \frac{n_{ECCE,q}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + 1 + n' + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(e1)}$$

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

Value of 'TPC command for PUCCH'	$n_{\mathrm{PUCCH},j}^{(1)}$ or $(n_{\mathrm{PUCCH},j}^{(1)}, n_{\mathrm{PUCCH},j+1}^{(1)})$
'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: $(n_{\mathrm{PUCCH},j}^{(1)}, n_{\mathrm{PUCCH},j+1}^{(1)})$ 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 $A = 2$

HARQ-ACK(0)	HARQ-ACK(1)	$n_{\mathrm{PUCCH}}^{(1)}$	$b(0)b(1)$
ACK	ACK	$n_{\mathrm{PUCCH},1}^{(1)}$	1,1
ACK	NACK/DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	1,1
NACK/DTX	ACK	$n_{\mathrm{PUCCH},1}^{(1)}$	0,0
NACK	NACK/DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	0,0
DTX	NACK/DTX	No Transmission	

Table 10.1.2.2.1-4: Transmission of Format 1b HARQ-ACK channel selection for $A=3$

HARQ-ACK(0)	HARQ-ACK(1)	HARQ-ACK(2)	$n_{\mathrm{PUCCH}}^{(1)}$	$b(0)b(1)$
ACK	ACK	ACK	$n_{\mathrm{PUCCH},1}^{(1)}$	1,1
ACK	NACK/DTX	ACK	$n_{\mathrm{PUCCH},1}^{(1)}$	1,0
NACK/DTX	ACK	ACK	$n_{\mathrm{PUCCH},1}^{(1)}$	0,1
NACK/DTX	NACK/DTX	ACK	$n_{\mathrm{PUCCH},2}^{(1)}$	1,1
ACK	ACK	NACK/DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	1,1
ACK	NACK/DTX	NACK/DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	1,0
NACK/DTX	ACK	NACK/DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	0,1
NACK/DTX	NACK/DTX	NACK	$n_{\mathrm{PUCCH},2}^{(1)}$	0,0
NACK	NACK/DTX	DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	0,0
NACK/DTX	NACK	DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	0,0
DTX	DTX	DTX	No Transmission	

Table 10.1.2.2.1-5: Transmission of Format 1b HARQ-ACK channel selection for $A = 4$

HARQ-ACK(0)	HARQ-ACK(1)	HARQ-ACK(2)	HARQ-ACK(3)	$n^{(1)}_{\text{PUCCH}}$	$b(0)b(1)$
ACK	ACK	ACK	ACK	$n^{(1)}_{\text{PUCCH},1}$	1,1
ACK	NACK/DTX	ACK	ACK	$n^{(1)}_{\text{PUCCH},2}$	0,1
NACK/DTX	ACK	ACK	ACK	$n^{(1)}_{\text{PUCCH},1}$	0,1
NACK/DTX	NACK/DTX	ACK	ACK	$n^{(1)}_{\text{PUCCH},3}$	1,1
ACK	ACK	ACK	NACK/DTX	$n^{(1)}_{\text{PUCCH},1}$	1,0
ACK	NACK/DTX	ACK	NACK/DTX	$n^{(1)}_{\text{PUCCH},2}$	0,0
NACK/DTX	ACK	ACK	NACK/DTX	$n^{(1)}_{\text{PUCCH},1}$	0,0
NACK/DTX	NACK/DTX	ACK	NACK/DTX	$n^{(1)}_{\text{PUCCH},3}$	1,0
ACK	ACK	NACK/DTX	ACK	$n^{(1)}_{\text{PUCCH},2}$	1,1
ACK	NACK/DTX	NACK/DTX	ACK	$n^{(1)}_{\text{PUCCH},2}$	1,0
NACK/DTX	ACK	NACK/DTX	ACK	$n^{(1)}_{\text{PUCCH},3}$	0,1
NACK/DTX	NACK/DTX	NACK/DTX	ACK	$n^{(1)}_{\text{PUCCH},3}$	0,0
ACK	ACK	NACK/DTX	NACK/DTX	$n^{(1)}_{\text{PUCCH},0}$	1,1
ACK	NACK/DTX	NACK/DTX	NACK/DTX	$n^{(1)}_{\text{PUCCH},0}$	1,0
NACK/DTX	ACK	NACK/DTX	NACK/DTX	$n^{(1)}_{\text{PUCCH},0}$	0,1
NACK/DTX	NACK	NACK/DTX	NACK/DTX	$n^{(1)}_{\text{PUCCH},0}$	0,0
NACK	NACK/DTX	NACK/DTX	NACK/DTX	$n^{(1)}_{\text{PUCCH},0}$	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 $n^{(3,\tilde{p})}_{\text{PUCCH}}$ or $n^{(1,\tilde{p})}_{\text{PUCCH}}$ for transmission of HARQ-ACK in subframe n for $\tilde{p}$ mapped to antenna port p where

- for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe $n-4$, or for a PDCCH indicating downlink SPS release (defined in Subclause 9.2) in subframe $n-4$ on the primary cell, the UE shall use PUCCH format 1a/1b and PUCCH resource $n^{(1,\tilde{p})}_{\text{PUCCH}}$ with $n^{(1,\tilde{p}_0)}_{\text{PUCCH}} = n_{\text{CCE}} + N^{(1)}_{\text{PUCCH}}$ for antenna port p_0, where n_{CCE} 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 $N^{(1)}_{\text{PUCCH}}$ is configured by higher layers. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port p_1 is given by $n^{(1,\tilde{p}_1)}_{\text{PUCCH}} = n_{\text{CCE}} + 1 + N^{(1)}_{\text{PUCCH}}$.
- for a PDSCH transmission only on the primary cell where there is not a corresponding PDCCH/EPDCCH detected in subframe $n-4$, the UE shall use PUCCH format 1a/1b and PUCCH resource $n^{(1,\tilde{p})}_{\text{PUCCH}}$ where the value of $n^{(1,\tilde{p})}_{\text{PUCCH}}$ 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 $n^{(1,\tilde{p}_0)}_{\text{PUCCH}}$ for antenna port p_0 and the second PUCCH

resource $n_{\text{PUCCH}}^{(1,\tilde{p}_1)}$ for antenna port p_1, otherwise, the PUCCH resource value maps to a single PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p}_0)}$ for antenna port p_0.

- for a PDSCH transmission on the secondary cell indicated by the detection of a corresponding PDCCH/EPDCCH in subframe $n-4$, the UE shall use PUCCH format 3 and PUCCH resource $n_{\text{PUCCH}}^{(3,\tilde{p})}$ where the value of $n_{\text{PUCCH}}^{(3,\tilde{p})}$ 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 $n_{\text{PUCCH}}^{(3,\tilde{p}_0)}$ for antenna port p_0 and the second PUCCH resource $n_{\text{PUCCH}}^{(3,\tilde{p}_1)}$ for antenna port p_1, otherwise, the PUCCH resource value maps to a single PUCCH resource $n_{\text{PUCCH}}^{(3,\tilde{p}_0)}$ for antenna port p_0. 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 $n-4$, or for a EPDCCH indicating downlink SPS release (defined in Subclause 9.2) in subframe $n-4$ on the primary cell, the UE shall use PUCCH format 1a/1b and PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p})}$ given by
  - if EPDCCH-PRB-set q is configured for distributed transmission

$$n_{\text{PUCCH}}^{(1,\tilde{p}_0)} = n_{\text{ECCE,q}} + \Delta_{ARO} + N_{\text{PUCCH,q}}^{(\text{e1})}$$

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

$$n_{\text{PUCCH}}^{(1,\tilde{p}_0)} = \left\lfloor \frac{n_{\text{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + n' + \Delta_{ARO} + N_{\text{PUCCH,q}}^{(\text{e1})}$$

  for antenna port p_0, where $n_{\text{ECCE,q}}$ 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 q, Δ_{ARO} 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, $N_{\text{PUCCH,q}}^{(\text{e1})}$ for EPDCCH-PRB-set q is configured by the higher layer parameter *pucch-ResourceStartOffset-r11*, $N_{RB}^{ECCE,q}$ for EPDCCH-PRB-set q is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for localized EPDCCH transmission which is described in Subclause 6.8A.5 in [3]. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port p_1 is given by.

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

$$n_{\text{PUCCH}}^{(1,\tilde{p}_1)} = n_{\text{ECCE,q}} + 1 + \Delta_{ARO} + N_{\text{PUCCH,q}}^{(\text{e1})}$$

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

$$n_{\text{PUCCH}}^{(1,\tilde{p}_1)} = \left\lfloor \frac{n_{\text{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + 1 + n' + \Delta_{ARO} + N_{\text{PUCCH,q}}^{(\text{e1})}$$

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'	$n_{\text{PUCCH}}^{(3,\tilde{p})}$
'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

10.1.2.2.3 PUCCH format 4 HARQ-ACK procedure

For PUCCH format 4, the UE shall use PUCCH resource $n_{\text{PUCCH}}^{(4)}$ or $n_{\text{PUCCH}}^{(3,\tilde{p})}$ or $n_{\text{PUCCH}}^{(1,\tilde{p})}$ for transmission of HARQ-ACK and scheduling request (if any) and periodic CSI (if any) in subframe n for $\tilde{p}$ mapped to antenna port p where

- for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe $n-4$, or for a PDCCH indicating downlink SPS release (defined in Subclause 9.2) in subframe $n-4$ on the primary cell, the UE shall use PUCCH format 1a/1b and PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p})}$ with $n_{\text{PUCCH}}^{(1,\tilde{p}_0)} = n_{\text{CCE}} + N_{\text{PUCCH}}^{(1)}$ for antenna port p_0, where n_{CCE} 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 $N_{\text{PUCCH}}^{(1)}$ is configured by higher layers. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port p_1 is given by $n_{\text{PUCCH}}^{(1,\tilde{p}_1)} = n_{\text{CCE}} + 1 + N_{\text{PUCCH}}^{(1)}$.

- for a PDSCH transmission only on the primary cell where there is not a corresponding PDCCH/EPDCCH detected in subframe $n-4$, the UE shall use PUCCH format 1a/1b and PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p})}$ where the value of $n_{\text{PUCCH}}^{(1,\tilde{p})}$ 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 $n_{\text{PUCCH}}^{(1,\tilde{p}_0)}$ for antenna port p_0 and the second PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p}_1)}$ for antenna port p_1, otherwise, the PUCCH resource value maps to a single PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p}_0)}$ for antenna port p_0.

- for a PDSCH transmission on the secondary cell indicated by the detection of a corresponding PDCCH/EPDCCH in subframe $n-4$,

  - if the total number of HARQ-ACK bits O^{ACK} and scheduling request bit O^{SR} (if any) and periodic CSI bits $O_{\text{P-CSI}}$ (if any) is more than 22, the UE shall use PUCCH format 4 and PUCCH resource $n_{\text{PUCCH}}^{(4)}$ where the value of $n_{\text{PUCCH}}^{(4)}$ 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 O^{ACK} and scheduling request bit O^{SR} (if any) and periodic CSI bits $O_{\text{P-CSI}}$ (if any) is no more than 22, the UE shall use PUCCH format 3 and PUCCH resource $n_{\text{PUCCH}}^{(3,\tilde{p})}$ where the value of $n_{\text{PUCCH}}^{(3,\tilde{p})}$ 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 $n_{\text{PUCCH}}^{(3,\tilde{p})}$ for antenna port p_0 and the second PUCCH resource $n_{\text{PUCCH}}^{(3,\tilde{p})}$ for antenna port p_1, otherwise, the PUCCH resource value maps to a single PUCCH resource $n_{\text{PUCCH}}^{(3,\tilde{p})}$ for antenna port p_0. 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 $n-4$, or for a EPDCCH indicating downlink SPS release (defined in Subclause 9.2) in subframe $n-4$ on the primary cell, the UE shall use PUCCH format 1a/1b and PUCCH resource $n_{\mathrm{PUCCH}}^{(1,\tilde{p})}$ given by

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

$$n_{\mathrm{PUCCH}}^{(1,\tilde{p}_0)} = n_{\mathrm{ECCE,q}} + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

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

$$n_{\mathrm{PUCCH}}^{(1,\tilde{p}_0)} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + n' + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

  for antenna port p_0, where $n_{\mathrm{ECCE,q}}$ 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 q, Δ_{ARO} 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, $N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$ for EPDCCH-PRB-set q is configured by the higher layer parameter *pucch-ResourceStartOffset-r11*, $N_{RB}^{ECCE,q}$ for EPDCCH-PRB-set q is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for localized EPDCCH transmission which is described in Subclause 6.8A.5 in [3]. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port p_1 is given by.

  - if EPDCCH-PRB-set q is configured for distributed transmission $n_{\mathrm{PUCCH}}^{(1,\tilde{p}_1)} = n_{\mathrm{ECCE,q}} + 1 + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$

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

$$n_{\mathrm{PUCCH}}^{(1,\tilde{p}_1)} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + 1 + n' + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

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'	$n_{\mathrm{PUCCH}}^{(4,\tilde{p})}$
'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

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 Subclause 10.1.2.2.3, by replacing $n_{\mathrm{PUCCH}}^{(4)}$ with $n_{\mathrm{PUCCH}}^{(5)}$.

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, O in subframe n, based on the number of configured serving cells with subframe $n-4$ configured as a downlink or special subframe according to the DL-reference UL/DL configuration (defined in Subclause 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, O in subframe n, based on the number of configured serving cells with subframe $n-4$ configured as a downlink or special subframe except a special subframe of configurations 0 and 5 with normal downlink CP or of configurations 0 and 4 with extended downlink CP according to the DL-reference UL/DL configuration (defined in Subclause 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 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 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 n with PUCCH format 1b with channel selection, the FDD-TDD HARQ-ACK procedure follows HARQ-ACK procedure described in Subclause 10.1.2.1 if subframe $n-4$ is an uplink or a special subframe of configurations 0 and 5 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 the higher layer parameter *EIMTA-MainConfigServCell-r12*, 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 Subclause 10.1.2.2.1 otherwise.

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

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

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

HARQ-ACK transmission on two antenna ports $(p \in [p_0, p_1])$ is supported for PUCCH format 3.

HARQ-ACK transmission on two antenna ports $(p \in [p_0, p_1])$ 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 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) $n-k$, where $k \in K$ and K 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 when configured with more than one serving cell with frame structure type 2.

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.

A UE that is configured with the parameter *EIMTA-MainConfigServCell-r12* and configured with 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 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 M multiple downlink or special subframes associated with a single UL subframe *n*, where M is the number of elements in the set K defined in Table 10.1.3.1-1, by a logical AND operation of all the individual PDSCH transmission (with and without corresponding PDCCH/EPDCCH/MPDCCH) HARQ-ACKs and ACK in response to PDCCH/EPDCCH/MPDCCH 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 $M > 1$, where M is the number of elements in the set K defined in Table 10.1.3.1-1, 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 $M = 1$, 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 M multiple downlink or special subframes associated with a single UL subframe *n*, where M is defined in Subclause 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 M multiple downlink or special subframes associated with a single UL subframe *n*, where M is defined in Subclause 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 M multiple downlink or special subframes associated with a single UL subframe *n*, where M is the number of elements in the set K defined in Subclause 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 M multiple downlink or special subframes associated with a single UL subframe *n*, where M is the number of elements in the set K defined in Subclause 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, O, associated with an UL subframe *n*

according to $O = \sum_{c=1}^{N_{cells}^{DL}} O_c^{ACK}$ where N_{cells}^{DL} is the number of configured cells, and O_c^{ACK} is the number of HARQ-bits for the *c*-th serving cell defined in Subclause 7.3.

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

10.1.3.1 TDD HARQ-ACK procedure for one configured serving cell

HARQ-ACK transmission on two antenna ports ($p \in [p_0, p_1]$) 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 ($p \in [p_0, p_1]$) for PUCCH format 1b with channel selection.

The TDD HARQ-ACK procedure for a UE configured with PUCCH format 3 is as described in Subclause 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,* for TDD HARQ-ACK bundling or TDD HARQ-ACK multiplexing for one configured serving cell and a subframe *n* with $M = 1$ where M is the number of elements in the set K defined in Table 10.1.3.1-1, the UE shall use PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p})}$ for transmission of HARQ-ACK in subframe n for $\tilde{p}$ 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) $n-k$, where $k \in K$ and K (defined in Table 10.1.3.1-1) is a set of *M* elements $\{k_0, k_1, \cdots k_{M-1}\}$ 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 $n-k_m$, where k_m is the smallest value in set K such that UE detects a PDCCH/EPDCCH indicating PDSCH transmission or downlink SPS release within subframe(s) $n-k$ and $k \in K$, the UE first selects a c value out of {0, 1, 2, 3} which makes $N_c \le n_{\text{CCE}} < N_{c+1}$ and shall use $n_{\text{PUCCH}}^{(1,\tilde{p}_0)} = (M-m-1)\cdot N_c + m \cdot N_{c+1} + n_{\text{CCE}} + N_{\text{PUCCH}}^{(1)}$ for antenna port p_0, where $N_{\text{PUCCH}}^{(1)}$ is configured by higher layers, $N_c = \max\left\{0, \left\lfloor [N_{\text{RB}}^{\text{DL}} \cdot (N_{\text{sc}}^{\text{RB}} \cdot c - 4)]/36 \right\rfloor\right\}$, and n_{CCE} is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n-k_m$ 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 p_1 is given by $n_{\text{PUCCH}}^{(1,\tilde{p}_1)} = (M-m-1)\cdot N_c + m \cdot N_{c+1} + n_{\text{CCE}} + 1 + N_{\text{PUCCH}}^{(1)}$.

- 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) $n-k$, where $k \in K$ and K is defined in Table 10.1.3.1-1, the UE shall use PUCCH format 1a/1b and PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p})}$ with the value of $n_{\text{PUCCH}}^{(1,\tilde{p})}$ 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 $n_{\text{PUCCH}}^{(1,\tilde{p}_0)}$ for antenna port p_0 and the second PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p}_1)}$ for antenna port p_1, otherwise, the PUCCH resource value maps to a single PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p}_0)}$ for antenna port p_0.

- 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) $n-k$, where $k \in K$ and K (defined in Table 10.1.3.1-1) is a set of *M* elements $\{k_0, k_1, \cdots k_{M-1}\}$ 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 $n-k_m$, where k_m is the smallest value in set K such that UE detects a

PDCCH/EPDCCH indicating PDSCH transmission or downlink SPS release within subframe(s) $n-k$ and $k \in K$, the UE shall use

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

$$n_{\mathrm{PUCCH}}^{(1,\tilde{p}_0)} = n_{\mathrm{ECCE,q}} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

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

$$n_{\mathrm{PUCCH}}^{(1,\tilde{p}_0)} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + n' + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

for antenna port p_0, where $n_{\mathrm{ECCE,q}}$ 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 q in subframe $n-k_m$ and the corresponding m, $N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$ for EPDCCH-PRB-set q is configured by the higher layer parameter *pucch-ResourceStartOffset-r11*, $N_{RB}^{ECCE,q}$ for EPDCCH-PRB-set q in subframe $n-k_m$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n-k_m$ which is described in Subclause 6.8A.5 in [3]. If $m=0$, Δ_{ARO} 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 $m>0$, Δ_{ARO} 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 $n-k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs in EPDCCH-PRB-set q configured for that UE in subframe $n-k_{i1}$. If the UE is not configured to monitor EPDCCH in subframe $n-k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs computed assuming EPDCCH-PRB-set q is configured for that UE in subframe $n-k_{i1}$. For normal downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 5, $N_{ECCE,q,n-k_{i1}}$ is equal to 0. For extended downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 4 or 7, $N_{ECCE,q,n-k_{i1}}$ 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 p_1 is given by

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

$$n_{\mathrm{PUCCH}}^{(1,\tilde{p}_1)} = n_{\mathrm{ECCE,q}} + 1 + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

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

$$n_{\mathrm{PUCCH}}^{(1,\tilde{p}_1)} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + 1 + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + n' + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

- For a BL/CE UE, if there is only a PDSCH transmission within one or more consecutive BL/CE downlink subframe(s) where subframe $n-k$, is the last subframe in which the PDSCH is transmitted where $k \in K$ and K 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 $n_{\mathrm{PUCCH}}^{(1,\mathrm{p}_0)}$ where the value of $n_{\mathrm{PUCCH}}^{(1,\mathrm{p}_0)}$ 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) $n-k$, where $k \in K$ and K (defined in Table 10.1.3.1-1) is a set of M elements $\{k_0, k_1, \cdots k_{M-1}\}$ depending on the subframe n and the UL/DL configuration (defined in

Table 4.2-2 in [3]) and subframe $n-k_m$ is the last subframe in which the PDSCH or MPDCCH indicating downlink SPS release is transmitted and there is no $k_{m'} \in K$ where $k_{m'} < k_m$ and subframe $n-k_{m'}$ 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 q is configured for distributed transmission

$$n_{\mathrm{PUCCH}}^{(1,\mathrm{p}_0)} = n_{\mathrm{ECCE,q}} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(m1)}$$

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

$$n_{\mathrm{PUCCH}}^{(1,\mathrm{p}_0)} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + n' + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(m1)}$$

for antenna port p_0, where $n_{\mathrm{ECCE,q}}$ 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 q, $N_{\mathrm{PUCCH,q}}^{(m1)}$ for MPDCCH-PRB-set q 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,

$N_{RB}^{ECCE,q}$ for MPDCCH-PRB-set q is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for the MPDCCH transmission which is described in Subclause 6.8A.5 in [3]. If $m=0$, Δ_{ARO} 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 $m>0$, Δ_{ARO} 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 $n-k_{i1}$ is a BL/CE downlink subframe, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs in MPDCCH-PRB-set q configured for that UE in subframe $n-k_{i1}$. If subframe $n-k_{i1}$ is not a BL/CE downlink subframe, $N_{ECCE,q,n-k_{i1}}$ is equal to 0. If subframe $n-k_{i1}$ is a BL/CE downlink special subframe in which MPDCCH is not supported, the UE shall calculate $N_{ECCE,q,n-k_{i1}}$ by assuming $N_{\mathrm{EREG}}^{\mathrm{ECCE}}=4$ for normal cyclic prefix and $N_{\mathrm{EREG}}^{\mathrm{ECCE}}=8$ for extended cyclic prefix. If an MPDCCH-PRB-set p is 2+4, then $N_{ECCE,q,n-k_{i1}} = 6 \cdot N_{RB}^{ECCE,q}$. When an MPDCCH-PRB-set p is 2+4, following procedures is applied.

- if the detected MPDCCH is located within 2 PRB set, $n_{\mathrm{PUCCH}}^{(1,\mathrm{p}_0)}$ is obtained by above procedure.
- if the detected MPDCCH is located within 4 PRB set, $n_{\mathrm{PUCCH}}^{(1,\mathrm{p}_0)}$ is the sum between $2N_{RB}^{ECCE,q}$ and the value obtained by above procedure.
- if the detected MPDCCH is MPDCCH format 5, $n_{\mathrm{PUCCH}}^{(1,\mathrm{p}_0)}$ is obtained by the above procedure with $n_{\mathrm{ECCE,q}}$ = 0.

Table 10.1.3.1-1: Downlink association set K : $\{k_0, k_1, \cdots k_{M-1}\}$ 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 K^A: $\{k_0^A, k_1^A, \ldots, k_{M^A-1}^A\}$ 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 10.1.3.1-2: Mapping of ACK/NACK Resource offset Field in DCI format 1A/1B/1D/1/2A/2/2B/2C/2D/6-1A/6-1B to Δ_{ARO} values for TDD when $m > 0$

ACK/NACK Resource offset field in DCI format 1A/1B/1D/1/2A/2/2B/2C/2D	Δ_{ARO}
0	0
1	$-\sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} - 2$
2	$-\sum_{i1=m-\lceil m/3 \rceil}^{m-1} N_{ECCE,q,n-k_{i1}} - 1$
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 Δ'_{ARO} values for TDD when $i4 = M'$ and $i5 \neq 0$

ACK/NACK Resource offset field in DCI format 1A/1B/1D/1/2A/2/2B/2C/2D	Δ'_{ARO}
0	0
1	$-\sum_{i1=0}^{i4-1} N'_{ECCE,q,n-k'_{i1}} - \sum_{i1=0}^{i5-1} N'_{ECCE,q,n-k^A_{i1}} - 2$
2	$-\sum_{i1=\min(i4,\, i4-\delta+i5)}^{i4-1} N'_{ECCE,q,n-k'_{i1}} - \sum_{i1=\max(0,\, i5-\delta)}^{i5-1} N'_{ECCE,q,n-k^A_{i1}} - 1 \quad ,\delta = \left\lceil \frac{(i4+i5)}{3} \right\rceil$
3	2

If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12*, for TDD HARQ-ACK multiplexing and sub-frame n with $M > 1$ and one configured serving cell, where M is the number of elements in the set K defined in Table 10.1.3.1-1, denote $n^{(1)}_{\mathrm{PUCCH},i}$ as the PUCCH resource derived from sub-frame $n-k_i$ and HARQ-ACK(i) as the ACK/NACK/DTX response from sub-frame $n-k_i$, where $k_i \in K$ (defined in Table 10.1.3.1-1) and $0 \le i \le M-1$.

- For a PDSCH transmission indicated by the detection of corresponding PDCCH or a PDCCH indicating downlink SPS release in sub-frame $n-k_i$ where $k_i \in K$, the PUCCH resource $n^{(1)}_{\mathrm{PUCCH},i} = (M-i-1)\cdot N_c + i\cdot N_{c+1} + n_{\mathrm{CCE},i} + N^{(1)}_{\mathrm{PUCCH}}$, where c is selected from {0, 1, 2, 3} such that $N_c \le n_{\mathrm{CCE},i} < N_{c+1}$, $N_c = \max\left\{0, \left\lfloor [N^{\mathrm{DL}}_{\mathrm{RB}} \cdot (N^{\mathrm{RB}}_{\mathrm{sc}} \cdot c - 4)]/36 \right\rfloor\right\}$, $n_{\mathrm{CCE},i}$ is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n-k_i$, and $N^{(1)}_{\mathrm{PUCCH}}$ is configured by higher layers.
- For a PDSCH transmission where there is not a corresponding PDCCH/EPDCCH detected in subframe $n-k_i$, the value of $n^{(1)}_{\mathrm{PUCCH},i}$ 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 $n-k_i$ where $k_i \in K$, the UE shall use
  - if EPDCCH-PRB-set q is configured for distributed transmission

$$n^{(1)}_{\mathrm{PUCCH,i}} = n_{\mathrm{ECCE,q}} + \sum_{i1=0}^{i-1} N_{ECCE,q,n-k_{i1}} + \Delta_{ARO} + N^{(e1)}_{\mathrm{PUCCH,q}}$$

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

$$n^{(1)}_{\mathrm{PUCCH,i}} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N^{ECCE,q}_{RB}} \right\rfloor \cdot N^{ECCE,q}_{RB} + \sum_{i1=0}^{i-1} N_{ECCE,q,n-k_{i1}} + n' + \Delta_{ARO} + N^{(e1)}_{\mathrm{PUCCH,q}}$$

  where $n_{\mathrm{ECCE,q}}$ 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 q in subframe $n-k_i$, $N^{(e1)}_{\mathrm{PUCCH,q}}$ for EPDCCH-PRB-set q is configured by the higher layer parameter *pucch-ResourceStartOffset-r11*, $N^{ECCE,q}_{RB}$ for EPDCCH-PRB-set q in subframe $n-k_i$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n-k_i$ which is described in Subclause 6.8A.5 in [3]. If $i=0$, Δ_{ARO} 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 $i > 0$, Δ_{ARO} 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 m in the table is substituted with i. If the UE is configured to monitor EPDCCH in subframe $n-k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs in EPDCCH-PRB-set q configured for that UE in subframe $n-k_{i1}$. If the UE is not configured to monitor EPDCCH in subframe $n-k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs computed assuming EPDCCH-PRB-set q is configured for that UE in subframe $n-k_{i1}$. For normal downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 5, $N_{ECCE,q,n-k_{i1}}$ is equal to 0. For extended downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 4 or 7, $N_{ECCE,q,n-k_{i1}}$ is equal to 0.

- For a BL/CE UE, for a PDSCH transmission detected in subframe $n-k_i$ without a corresponding MPDCCH, the value of $n^{(1)}_{\text{PUCCH},i}$ is determined according to higher layer configuration and Table 9.2-2.

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

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

$$n^{(1)}_{\text{PUCCH,i}} = n_{\text{ECCE,q}} + \sum_{i1=0}^{i-1} N_{ECCE,q,n-k_{i1}} + \Delta_{ARO} + N^{(m1)}_{\text{PUCCH,q}}$$

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

$$n^{(1)}_{\text{PUCCH,i}} = \left\lfloor \frac{n_{\text{ECCE,q}}}{N^{ECCE,q}_{RB}} \right\rfloor \cdot N^{ECCE,q}_{RB} + \sum_{i1=0}^{i-1} N_{ECCE,q,n-k_{i1}} + n' + \Delta_{ARO} + N^{(m1)}_{\text{PUCCH,q}}$$

  where $n_{\text{ECCE,q}}$ 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 q, $N^{(m1)}_{\text{PUCCH,q}}$ for MPDCCH-PRB-set q 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,

  $N^{ECCE,q}_{RB}$ for MPDCCH-PRB-set q is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for the MPDCCH transmission which is described in Subclause 6.8A.5 in [3]. If $i = 0$, Δ_{ARO} 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 $i > 0$, Δ_{ARO} 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 m in the table is substituted with i. If subframe $n-k_{i1}$ is a BL/CE downlink subframe, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs in MPDCCH-PRB-set q configured for that UE in subframe $n-k_{i1}$. If subframe $n-k_{i1}$ is not a BL/CE downlink subframe, $N_{ECCE,q,n-k_{i1}}$ is equal to 0. If subframe $n-k_{i1}$ is a BL/CE downlink special subframe in which MPDCCH is not supported, the UE shall calculate $N_{ECCE,q,n-k_{i1}}$ by assuming $N^{\text{ECCE}}_{\text{EREG}} = 4$ for normal cyclic prefix and $N^{\text{ECCE}}_{\text{EREG}} = 8$ for extended cyclic prefix. If an MPDCCH-PRB-set p is 2+4, then $N_{ECCE,q,n-k_{i1}} = 6 \cdot N^{ECCE,q}_{RB}$. When an MPDCCH-PRB-set p is 2+4, following procedures is applied.

- if the detected MPDCCH is located within 2 PRB set, $n_{\text{PUCCH}}^{(1,p_0)}$ is obtained by above procedure.
- if the detected MPDCCH is located within 4 PRB set, $n_{\text{PUCCH}}^{(1,p_0)}$ is the sum between $2N_{RB}^{ECCE,q}$ and the value obtained by above procedure.
- if the detected MPDCCH is MPDCCH format 5, $n_{\text{PUCCH}}^{(1,p_0)}$ is obtained by the above procedure with $n_{\text{ECCE,q}} = 0$.

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

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

If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12,* for TDD HARQ-ACK multiplexing and sub-frame n, denote $n_{\text{PUCCH},i0}^{(1)}$ as the PUCCH resource derived from sub-frame $n-k_i$ and HARQ-ACK(i0) as the ACK/NACK/DTX response from sub-frame $n-k_i$, where $k_i \in K$, and $0 \le i \le M-1$.

- $i0$ corresponding to each subframe $n-k_i, \forall i, 0 \le i \le M-1$ is determined as follows

  Set $b = 0$;

  for $i2 = 0,1,\ldots M^{'}-1$

  if the value of k'_{i2} is the same as the value of an element k_i in set K, where $k'_{i2} \in K'$,

  $i0$ corresponding to subframe $n-k_i = b$;

  $b = b+1$

  end if

  end for

  for $i3 = 0,1,..., M^{A}-1$

  if the value of k_{i3}^{A} is same as the value of an element k_i in set K, where $k_{i3}^{A} \in K^{A}$ (defined in Table 10.1.3.1-1A)

  $i0$ corresponding to subframe $n-k_i = b$;

  $b = b+1$

  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 $n-k_i$,
  - if the value of k_i is same as the value of an element k'_{i2} in set K', the PUCCH resource $n_{\text{PUCCH},i0}^{(1)}$ is given by $n_{\text{PUCCH},i0}^{(1)} = (M'-i2-1)\cdot N_c + i2\cdot N_{c+1} + n_{\text{CCE},i} + N_{\text{PUCCH}}^{(1)}$;

- otherwise, if the value of k_i is same as the value of an element k_{i3}^A in set K^A, where $k_{i3}^A \in K^A$ (defined in Table 10.1.3.1-1A), the UE shall set, the PUCCH resource $n_{\text{PUCCH},i0}^{(1)}$ is given by

  $n_{PUCCH,i0}^{(1)} = (M^A - i3 - 1) \cdot N_c + i3 \cdot N_{c+1} + n_{CCE,i} + N_{PUCCH}^{K^A}$;

  where M^A is the number of elements in the set K^A defined in Table 10.1.3.1-1A , c is selected from {0, 1, 2, 3} such that $N_c \le n_{\text{CCE},i} < N_{c+1}$, $N_c = \max\left\{0, \left\lfloor [N_{\text{RB}}^{\text{DL}} \cdot (N_{\text{sc}}^{\text{RB}} \cdot c - 4)]/36 \right\rfloor\right\}$, $n_{\text{CCE},i}$ is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n - k_i$, and $N_{\text{PUCCH}}^{\text{K}^A}$, $N_{\text{PUCCH}}^{(1)}$, are configured by higher layers.

- For a PDSCH transmission where there is not a corresponding PDCCH/EPDCCH detected in subframe $n - k_i$, the value of $n_{\text{PUCCH},i0}^{(1)}$ 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 $n - k_i$ where $k_i \in K$, the UE shall use

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

    $n_{\text{PUCCH,i0}}^{(1)} = n_{\text{ECCE,q}} + \sum_{i1=0}^{i4-1} N'_{ECCE,q,n-k'_{i1}} + \sum_{i1=0}^{i5-1} N'_{ECCE,q,n-k_{i1}^A} + \Delta'_{ARO} + N_{\text{PUCCH,q}}^{(\text{e1})}$

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

    $n_{\text{PUCCH,i0}}^{(1)} = \left\lfloor \frac{n_{\text{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + \sum_{i1=0}^{i4-1} N'_{ECCE,q,n-k'_{i1}} + \sum_{i1=0}^{i5-1} N'_{ECCE,q,n-k_{i1}^A} + n' + \Delta'_{ARO} + N_{\text{PUCCH,q}}^{(\text{e1})}$

    where

    - if the value of k_i is same as the value of an index k'_{i2} , where $k'_{i2} \in K'$, then $i4 = i2$ and $i5 = 0$;

    - otherwise, if the value of k_i is same as the value of an index k_{i3}^A, where $k_{i3}^A \in K^A$, then $i4 = M'$ and $i5 = i3$;

, and where $n_{\text{ECCE,q}}$ 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 q in subframe $n - k_i$, $N_{\text{PUCCH,q}}^{(\text{e1})}$ for EPDCCH-PRB-set q is configured by the higher layer parameter *pucch-ResourceStartOffset-r11* , $N_{RB}^{ECCE,q}$ for EPDCCH-PRB-set q in subframe $n - k_i$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n - k_i$ which is described in Subclause 6.8A.5 in [3].

Δ'_{ARO} is determined as follows

- If $i4 = 0$ and $i5 = 0$, Δ'_{ARO} 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 $0 < i4 < M'$ and $i5 = 0$, Δ'_{ARO} 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 Δ_{ARO} in the table is substituted with Δ'_{ARO} , the variable m in the table is substituted with $i4$, the variable N in the table is substituted with N' and the variable k_{i1} in the table is substituted with k'_{i1} .

- If $i4 = M'$ and $i5 \neq 0$, Δ'_{ARO} 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 u, $N'_{ECCE,q,u}$ is determined as follows

- If the UE is configured to monitor EPDCCH in subframe u, $N'_{ECCE,q,u}$ is equal to the number of ECCEs in EPDCCH-PRB-set q configured for that UE in subframe u.
- If the UE is not configured to monitor EPDCCH in subframe u, $N'_{ECCE,q,u}$ is equal to the number of ECCEs computed assuming EPDCCH-PRB-set q is configured for that UE in subframe u.
- For normal downlink CP, if subframe u is a special subframe with special subframe configuration 0 or 5, $N'_{ECCE,q,u}$ is equal to 0.
- For extended downlink CP, if subframe u is a special subframe with special subframe configuration 0 or 4 or 7, $N'_{ECCE,q,u}$ 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 $b(0),b(1)$ on PUCCH resource $n_{\mathrm{PUCCH}}^{(1,\tilde{p})}$ in sub-frame n for $\tilde{p}$ mapped to antenna port p using PUCCH format 1b according to Subclause 5.4.1 in [3] where

- $n_{\mathrm{PUCCH}}^{(1,\tilde{p})} = n_{\mathrm{PUCCH}}^{(1)}$ for antenna port p_0 and the value of $b(0),b(1)$ and the PUCCH resource $n_{\mathrm{PUCCH}}^{(1)}$ are generated by channel selection according to the selected set of Tables for M = 2, 3, and 4 respectively
- $n_{\mathrm{PUCCH}}^{(1,\tilde{p}_1)}$ for antenna port p_1, where $n_{\mathrm{PUCCH}}^{(1,\tilde{p}_1)}$ is selected from PUCCH resources $n_{\mathrm{PUCCH},i}^{(1,\tilde{p}_1)}$ configured by higher layers where $0 \le i \le M-1$, according to selected set of Tables for M = 2, 3, and 4 respectively by replacing $n_{\mathrm{PUCCH}}^{(1)}$ with $n_{\mathrm{PUCCH}}^{(1,\tilde{p}_1)}$ and replacing $n_{\mathrm{PUCCH},i}^{(1)}$ with $n_{\mathrm{PUCCH},i}^{(1,\tilde{p}_1)}$, 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)	$n_{\mathrm{PUCCH}}^{(1)}$	$b(0),b(1)$
ACK, ACK	$n_{\mathrm{PUCCH},1}^{(1)}$	1, 1
ACK, NACK/DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	0, 1
NACK/DTX, ACK	$n_{\mathrm{PUCCH},1}^{(1)}$	0, 0
NACK/DTX, NACK	$n_{\mathrm{PUCCH},1}^{(1)}$	1, 0
NACK, DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	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)	$n_{\mathrm{PUCCH}}^{(1)}$	$b(0), b(1)$
ACK, ACK, ACK	$n_{\mathrm{PUCCH},2}^{(1)}$	1, 1
ACK, ACK, NACK/DTX	$n_{\mathrm{PUCCH},1}^{(1)}$	1, 1
ACK, NACK/DTX, ACK	$n_{\mathrm{PUCCH},0}^{(1)}$	1, 1
ACK, NACK/DTX, NACK/DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	0, 1
NACK/DTX, ACK, ACK	$n_{\mathrm{PUCCH},2}^{(1)}$	1, 0
NACK/DTX, ACK, NACK/DTX	$n_{\mathrm{PUCCH},1}^{(1)}$	0, 0
NACK/DTX, NACK/DTX, ACK	$n_{\mathrm{PUCCH},2}^{(1)}$	0, 0
DTX, DTX, NACK	$n_{\mathrm{PUCCH},2}^{(1)}$	0, 1
DTX, NACK, NACK/DTX	$n_{\mathrm{PUCCH},1}^{(1)}$	1, 0
NACK, NACK/DTX, NACK/DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	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)	$n_{\mathrm{PUCCH}}^{(1)}$	$b(0), b(1)$
ACK, ACK, ACK, ACK	$n_{\mathrm{PUCCH},1}^{(1)}$	1, 1
ACK, ACK, ACK, NACK/DTX	$n_{\mathrm{PUCCH},1}^{(1)}$	1, 0
NACK/DTX,NACK/DTX,NACK,DTX	$n_{\mathrm{PUCCH},2}^{(1)}$	1, 1
ACK, ACK, NACK/DTX, ACK	$n_{\mathrm{PUCCH},1}^{(1)}$	1, 0
NACK, DTX, DTX, DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	1, 0
ACK, ACK, NACK/DTX, NACK/DTX	$n_{\mathrm{PUCCH},1}^{(1)}$	1, 0
ACK, NACK/DTX, ACK, ACK	$n_{\mathrm{PUCCH},3}^{(1)}$	0, 1
NACK/DTX, NACK/DTX, NACK/DTX, NACK	$n_{\mathrm{PUCCH},3}^{(1)}$	1, 1
ACK, NACK/DTX, ACK, NACK/DTX	$n_{\mathrm{PUCCH},2}^{(1)}$	0, 1
ACK, NACK/DTX, NACK/DTX, ACK	$n_{\mathrm{PUCCH},0}^{(1)}$	0, 1
ACK, NACK/DTX, NACK/DTX, NACK/DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	1, 1
NACK/DTX, ACK, ACK, ACK	$n_{\mathrm{PUCCH},3}^{(1)}$	0, 1
NACK/DTX, NACK, DTX, DTX	$n_{\mathrm{PUCCH},1}^{(1)}$	0, 0
NACK/DTX, ACK, ACK, NACK/DTX	$n_{\mathrm{PUCCH},2}^{(1)}$	1, 0
NACK/DTX, ACK, NACK/DTX, ACK	$n_{\mathrm{PUCCH},3}^{(1)}$	1, 0
NACK/DTX, ACK, NACK/DTX, NACK/DTX	$n_{\mathrm{PUCCH},1}^{(1)}$	0, 1
NACK/DTX, NACK/DTX, ACK, ACK	$n_{\mathrm{PUCCH},3}^{(1)}$	0, 1
NACK/DTX, NACK/DTX, ACK, NACK/DTX	$n_{\mathrm{PUCCH},2}^{(1)}$	0, 0
NACK/DTX, NACK/DTX, NACK/DTX, ACK	$n_{\mathrm{PUCCH},3}^{(1)}$	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)	$n_{\mathrm{PUCCH}}^{(1)}$	$b(0)b(1)$
ACK, ACK	$n_{\mathrm{PUCCH},1}^{(1)}$	1, 0
ACK, NACK/DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	1, 1
NACK/DTX, ACK	$n_{\mathrm{PUCCH},1}^{(1)}$	0, 1
NACK, NACK/DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	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)	$n_{\mathrm{PUCCH}}^{(1)}$	$b(0)b(1)$
ACK, ACK, ACK	$n_{\mathrm{PUCCH},2}^{(1)}$	1, 1
ACK, ACK, NACK/DTX	$n_{\mathrm{PUCCH},1}^{(1)}$	1, 0
ACK, NACK/DTX, ACK	$n_{\mathrm{PUCCH},2}^{(1)}$	1, 0
ACK, NACK/DTX, NACK/DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	1, 1
NACK/DTX, ACK, ACK	$n_{\mathrm{PUCCH},2}^{(1)}$	0, 1
NACK/DTX, ACK, NACK/DTX	$n_{\mathrm{PUCCH},1}^{(1)}$	0, 1
NACK/DTX, NACK/DTX, ACK	$n_{\mathrm{PUCCH},2}^{(1)}$	0, 0
NACK, NACK/DTX, NACK/DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	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)	$n_{\mathrm{PUCCH}}^{(1)}$	$b(0)b(1)$
ACK, ACK, ACK, ACK	$n_{\mathrm{PUCCH},1}^{(1)}$	1, 1
ACK, ACK, ACK, NACK/DTX	$n_{\mathrm{PUCCH},2}^{(1)}$	1, 1
ACK, ACK, NACK/DTX, ACK	$n_{\mathrm{PUCCH},0}^{(1)}$	1, 0
ACK, ACK, NACK/DTX, NACK/DTX	$n_{\mathrm{PUCCH},1}^{(1)}$	1, 0
ACK, NACK/DTX, ACK, ACK	$n_{\mathrm{PUCCH},3}^{(1)}$	1, 1
ACK, NACK/DTX, ACK, NACK/DTX	$n_{\mathrm{PUCCH},2}^{(1)}$	1, 0
ACK, NACK/DTX, NACK/DTX, ACK	$n_{\mathrm{PUCCH},0}^{(1)}$	0, 1
ACK, NACK/DTX, NACK/DTX, NACK/DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	1, 1
NACK/DTX, ACK, ACK, ACK	$n_{\mathrm{PUCCH},1}^{(1)}$	0, 0
NACK/DTX, ACK, ACK, NACK/DTX	$n_{\mathrm{PUCCH},2}^{(1)}$	0, 1
NACK/DTX, ACK, NACK/DTX, ACK	$n_{\mathrm{PUCCH},3}^{(1)}$	1, 0
NACK/DTX, ACK, NACK/DTX, NACK/DTX	$n_{\mathrm{PUCCH},1}^{(1)}$	0, 1
NACK/DTX, NACK/DTX, ACK, ACK	$n_{\mathrm{PUCCH},3}^{(1)}$	0, 1
NACK/DTX, NACK/DTX, ACK, NACK/DTX	$n_{\mathrm{PUCCH},2}^{(1)}$	0, 0
NACK/DTX, NACK/DTX, NACK/DTX, ACK	$n_{\mathrm{PUCCH},3}^{(1)}$	0, 0
NACK, NACK/DTX, NACK/DTX, NACK/DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	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 Subclause 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 Subclause 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 Subclause 10.1.3.2.1 or a PUCCH format 3 HARQ-ACK procedure as described in Subclause 10.1.3.2.2 or a PUCCH format 4 HARQ-ACK procedure as described in Subclause 10.1.3.2.3 or a PUCCH format 5 HARQ-ACK procedure as described in Subclause 10.1.3.2.4.

HARQ-ACK transmission on two antenna ports ($p \in [p_0, p_1]$) 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 Subclause 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 ($p \in [p_0, p_1]$) 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 $K' = K$ where the set K is defined in Table 10.1.3.1-1 (where "UL/DL configuration" in the table refers to the higher layer parameter *subframeAssignment*), and M' is the number of elements in set K'.

If a UE is configured with two serving cells with the same UL/DL configurations, then in the rest of this subcaluse, K is as defined in Sec 10.2 and M is the number of elements for subframe *n* in the set K, and $M_{primary} = M$.

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

- then the UE shall determine M for a subframe *n* in this Subclause as $M = \max\left(M_{primary}, M_{secondary}\right)$, where
  - $M_{primary}$ denotes the number of elements for subframe *n* in the set K for the primary cell (as defined in Subclause 10.2)
  - $M_{secondary}$ denotes the number of elements for subframe *n* in the set K_c for the secondary serving cell (as defined in Subclause 10.2)
- if $M_{secondary} < M$, then the UE shall, for the secondary serving cell, set HARQ-ACK(j) to DTX for *j* = $M_{secondary}$ to $M-1$.
- if $M_{primary} < M$, then the UE shall, for the primary cell, set HARQ-ACK(j) to DTX for *j* = $M_{primary}$ to $M-1$

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

For TDD HARQ-ACK multiplexing with PUCCH format 1b with channel selection and two configured serving cells and a subframe *n* with $M = 1$, a UE shall determine the number of HARQ-ACK bits, O, 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 $M \le 2$, the UE shall transmit $b(0)b(1)$ on PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p})}$ for $\tilde{p}$ mapped to antenna port *p* using PUCCH format 1b where

- $n_{\text{PUCCH}}^{(1,\tilde{p})} = n_{\text{PUCCH}}^{(1)}$ for antenna port p_0, where $n_{\text{PUCCH}}^{(1)}$ selected from A PUCCH resources, $n_{\text{PUCCH},j}^{(1)}$ where $0 \le j \le A-1$ and $A \in \{2,3,4\}$, according to Tables 10.1.3.2-1, 10.1.3.2-2, and 10.1.3.2-3 in subframe n using PUCCH format 1b.
- $n_{\text{PUCCH}}^{(1,\tilde{p}_1)}$ for antenna port p_1, where $n_{\text{PUCCH}}^{(1,\tilde{p}_1)}$ selected from A PUCCH resources, $n_{\text{PUCCH},j}^{(1,\tilde{p}_1)}$ configured by higher layers where $0 \le j \le A-1$ and $A \in \{2,3,4\}$, according to Tables 10.1.3.2-1, 10.1.3.2-2, and 10.1.3.2-3 by replacing $n_{\text{PUCCH}}^{(1)}$ with $n_{\text{PUCCH}}^{(1,\tilde{p}_1)}$ and replacing $n_{\text{PUCCH},j}^{(1)}$ with $n_{\text{PUCCH},j}^{(1,\tilde{p}_1)}$ in subframe n, when the UE is configured with two antenna port transmission for PUCCH format 1b with channel selection,

and for a subframe *n* with $M = 1$, 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 A PUCCH resources are given by Table 10.1.2.2.1-1. For a subframe *n* with $M = 2$, HARQ-ACK(*j*) denotes the ACK/NACK/DTX response for a PDSCH transmission or SPS release PDCCH/EPDCCH within subframe(s) given by set K on each serving cell, where the subframes on each serving cell for HARQ-ACK(*j*) and A 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 A PUCCH resources, $n_{\text{PUCCH},j}^{(1)}$ associated with HARQ-ACK(*j*) where $0 \le j \le A-1$ in Table 10.1.2.2.1-1 for $M = 1$ and Table 10.1.3.2-4 for $M = 2$, according to

- for a PDSCH transmission indicated by the detection of a corresponding PDCCH in subframe $n - k_m$, where $k_m \in K$ on the primary cell, or for a PDCCH indicating downlink SPS release (defined in Subclause 9.2) in subframe $n - k_m$, where $k_m \in K$ on the primary cell, the PUCCH resource is $n_{\text{PUCCH},j}^{(1)} = (M_{primary} - m - 1) \cdot N_c + m \cdot N_{c+1} + n_{\text{CCE},m} + N_{\text{PUCCH}}^{(1)}$, where c is selected from {0, 1, 2, 3} such that $N_c \le n_{\text{CCE},m} < N_{c+1}$, $N_c = \max\left\{0, \left\lfloor [N_{\text{RB}}^{\text{DL}} \cdot (N_{\text{sc}}^{\text{RB}} \cdot c - 4)]/36 \right\rfloor\right\}$ where $N_{\text{RB}}^{\text{DL}}$ is determined from the primary cell, and for a subframe *n* with $M = 1$ and a transmission mode that supports up to two transport blocks on the serving cell where the corresponding PDSCH transmission occurs, the PUCCH resource $n_{\text{PUCCH},j+1}^{(1)}$ is given by $n_{\text{PUCCH},j+1}^{(1)} = (M_{primary} - m - 1) \cdot N_c + m \cdot N_{c+1} + n_{\text{CCE},m} + 1 + N_{\text{PUCCH}}^{(1)}$ where $n_{\text{CCE,m}}$ is the number of the first CCE used for transmission of the corresponding DCI assignment and $N_{\text{PUCCH}}^{(1)}$ 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) $n - k$, where $k \in K$, the value of $n_{\text{PUCCH},j}^{(1)}$ 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 $n - k_m$ where $k_m \in K$ on the primary cell, the PUCCH resource $n_{\text{PUCCH},j}^{(1)}$ is given by

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

$$n_{\mathrm{PUCCH,j}}^{(1)} = n_{\mathrm{ECCE,q}} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

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

$$n_{\mathrm{PUCCH,j}}^{(1)} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + n' + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

where $n_{\mathrm{ECCE,q}}$ 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 q in subframe $n-k_m$, $N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$ for EPDCCH-PRB-set q is configured by the higher layer parameter *pucch-ResourceStartOffset-r11* , $N_{RB}^{ECCE,q}$ for EPDCCH-PRB-set q in subframe $n-k_m$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n-k_m$ which is described in Subclause 6.8A.5 in [3]. If $m=0$, Δ_{ARO} 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 $m>0$, Δ_{ARO} 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 $n-k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs in EPDCCH-PRB-set q configured for that UE in subframe $n-k_{i1}$. If the UE is not configured to monitor EPDCCH in subframe $n-k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs computed assuming EPDCCH-PRB-set q is configured for that UE in subframe $n-k_{i1}$. For normal downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 5, $N_{ECCE,q,n-k_{i1}}$ is equal to 0. For extended downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 4 or 7, $N_{ECCE,q,n-k_{i1}}$ is equal to 0. For a subframe *n* with $M=1$ and a transmission mode that supports up to two transport blocks on the serving cell where the corresponding PDSCH transmission occurs, the PUCCH resource $n_{\mathrm{PUCCH},j+1}^{(1)}$ is given by

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

$$n_{\mathrm{PUCCH}}^{(1,\tilde{p}_1)} = n_{\mathrm{ECCE,q}} + 1 + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

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

$$n_{\mathrm{PUCCH}}^{(1,\tilde{p}_1)} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + 1 + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + n' + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

- for a PDSCH transmission indicated by the detection of a corresponding PDCCH/EPDCCH within subframe(s) $n-k$, where $k \in K$ on the secondary cell, the value of $n_{\mathrm{PUCCH},j}^{(1)}$, and the value of $n_{\mathrm{PUCCH},j+1}^{(1)}$ for a subframe *n* with $M=2$ or for a subframe *n* with $M=1$ 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 $M=1$, or for a subframe *n* with $M=2$, a PUCCH resource value in Table 10.1.2.2.1-2 maps to two PUCCH resources $(n_{\mathrm{PUCCH},j}^{(1)}, n_{\mathrm{PUCCH},j+1}^{(1)})$, otherwise, the PUCCH resource value maps to a single PUCCH resource $n_{\mathrm{PUCCH},j}^{(1)}$. 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) $n-k$, where $k \in K$.

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

HARQ-ACK(0), HARQ-ACK(1)	$n^{(1)}_{\text{PUCCH}}$	$b(0)b(1)$
ACK, ACK	$n^{(1)}_{\text{PUCCH},1}$	1, 0
ACK, NACK/DTX	$n^{(1)}_{\text{PUCCH},0}$	1, 1
NACK/DTX, ACK	$n^{(1)}_{\text{PUCCH},1}$	0, 1
NACK, NACK/DTX	$n^{(1)}_{\text{PUCCH},0}$	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)	$n^{(1)}_{\text{PUCCH}}$	$b(0)b(1)$
ACK, ACK, ACK	$n^{(1)}_{\text{PUCCH},2}$	1, 1
ACK, ACK, NACK/DTX	$n^{(1)}_{\text{PUCCH},1}$	1, 0
ACK, NACK/DTX, ACK	$n^{(1)}_{\text{PUCCH},2}$	1, 0
ACK, NACK/DTX, NACK/DTX	$n^{(1)}_{\text{PUCCH},0}$	1, 1
NACK/DTX, ACK, ACK	$n^{(1)}_{\text{PUCCH},2}$	0, 1
NACK/DTX, ACK, NACK/DTX	$n^{(1)}_{\text{PUCCH},1}$	0, 1
NACK/DTX, NACK/DTX, ACK	$n^{(1)}_{\text{PUCCH},2}$	0, 0
NACK, NACK/DTX, NACK/DTX	$n^{(1)}_{\text{PUCCH},0}$	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)	$n_{\mathrm{PUCCH}}^{(1)}$	$b(0)b(1)$
ACK, ACK, ACK, ACK	$n_{\mathrm{PUCCH},1}^{(1)}$	1, 1
ACK, ACK, ACK, NACK/DTX	$n_{\mathrm{PUCCH},2}^{(1)}$	1, 1
ACK, ACK, NACK/DTX, ACK	$n_{\mathrm{PUCCH},0}^{(1)}$	1, 0
ACK, ACK, NACK/DTX, NACK/DTX	$n_{\mathrm{PUCCH},1}^{(1)}$	1, 0
ACK, NACK/DTX, ACK, ACK	$n_{\mathrm{PUCCH},3}^{(1)}$	1, 1
ACK, NACK/DTX, ACK, NACK/DTX	$n_{\mathrm{PUCCH},2}^{(1)}$	1, 0
ACK, NACK/DTX, NACK/DTX, ACK	$n_{\mathrm{PUCCH},0}^{(1)}$	0, 1
ACK, NACK/DTX, NACK/DTX, NACK/DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	1, 1
NACK/DTX, ACK, ACK, ACK	$n_{\mathrm{PUCCH},1}^{(1)}$	0, 0
NACK/DTX, ACK, ACK, NACK/DTX	$n_{\mathrm{PUCCH},2}^{(1)}$	0, 1
NACK/DTX, ACK, NACK/DTX, ACK	$n_{\mathrm{PUCCH},3}^{(1)}$	1, 0
NACK/DTX, ACK, NACK/DTX, NACK/DTX	$n_{\mathrm{PUCCH},1}^{(1)}$	0, 1
NACK/DTX, NACK/DTX, ACK, ACK	$n_{\mathrm{PUCCH},3}^{(1)}$	0, 1
NACK/DTX, NACK/DTX, ACK, NACK/DTX	$n_{\mathrm{PUCCH},2}^{(1)}$	0, 0
NACK/DTX, NACK/DTX, NACK/DTX, ACK	$n_{\mathrm{PUCCH},3}^{(1)}$	0, 0
NACK, NACK/DTX, NACK/DTX, NACK/DTX	$n_{\mathrm{PUCCH},0}^{(1)}$	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 $M = 2$

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 n with $M > 2$ and two configured serving cells, denotes $n_{\mathrm{PUCCH},i}^{(1)}$ $0 \le i \le 3$ as the PUCCH resource derived from the transmissions in M downlink or special sub-frames associated with the UL subframe n. $n_{\mathrm{PUCCH},0}^{(1)}$ and $n_{\mathrm{PUCCH},1}^{(1)}$ are associated with the PDSCH transmission(s) or a PDCCH/EPDCCH indicating downlink SPS release (defined in Subclause 9.2) on the primary cell and $n_{\mathrm{PUCCH},2}^{(1)}$ and $n_{\mathrm{PUCCH},3}^{(1)}$ 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) $n-k$, where $k \in K$,
  - the value of $n_{\mathrm{PUCCH},0}^{(1)}$ 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 $n-k_m$, where $k_m \in K$ 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$ with the DAI value in the PDCCH equal to '1', the PUCCH resource $n^{(1)}_{\text{PUCCH},1} = (M_{primary} - m - 1)\cdot N_c + m \cdot N_{c+1} + n_{\text{CCE},m} + N^{(1)}_{\text{PUCCH}}$ where c is selected from {0, 1, 2, 3} such that $N_c \le n_{\text{CCE},m} < N_{c+1}$, $N_c = \max\left\{0, \left\lfloor [N^{\text{DL}}_{\text{RB}} \cdot (N^{\text{RB}}_{\text{sc}} \cdot c - 4)]/36 \right\rfloor\right\}$, where $n_{\text{CCE,m}}$ is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n-k_m$ and $N^{(1)}_{\text{PUCCH}}$ is configured by higher layers.
- for a PDSCH transmission on the primary cell indicated by the detection of a corresponding EPDCCH in subframe $n-k_m$, where $k_m \in K$ 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$ with the DAI value in the EPDCCH equal to '1', the PUCCH resource is given by
  - If EPDCCH-PRB-set q is configured for distributed transmission

$$n^{(1)}_{\text{PUCCH},1} = n_{\text{ECCE,q}} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + \Delta_{ARO} + N^{(\text{e1})}_{\text{PUCCH,q}}$$

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

$$n^{(1)}_{\text{PUCCH},1} = \left\lfloor \frac{n_{\text{ECCE,q}}}{N^{ECCE,q}_{RB}} \right\rfloor \cdot N^{ECCE,q}_{RB} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + n' + \Delta_{ARO} + N^{(\text{e1})}_{\text{PUCCH,q}}$$

  where $n_{\text{ECCE,q}}$ 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 q in subframe $n-k_m$, $N^{(\text{e1})}_{\text{PUCCH,q}}$ for EPDCCH-PRB-set q is configured by the higher layer parameter *pucch-ResourceStartOffset-r11*, $N^{ECCE,q}_{RB}$ for EPDCCH-PRB-set q in subframe $n-k_m$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n-k_m$ which is described in Subclause 6.8A.5 in [3]. If $m=0$, Δ_{ARO} 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 $m>0$, Δ_{ARO} 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 $n-k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs in EPDCCH-PRB-set q configured for that UE in subframe $n-k_{i1}$. If the UE is not configured to monitor EPDCCH in subframe $n-k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs computed assuming EPDCCH-PRB-set q is configured for that UE in subframe $n-k_{i1}$. For normal downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 5, $N_{ECCE,q,n-k_{i1}}$ is equal to 0. For extended downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 4 or 7, $N_{ECCE,q,n-k_{i1}}$ 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) $n-k$, where $k \in K$,
  - the value of $n^{(1)}_{\text{PUCCH},0}$ 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 $n-k_i$, where $k_i \in K$ 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 Subclause 9.2) in subframe $n-k_i$, where $k_i \in K$ with the DAI value in the PDCCH equal to '1',

  - if the value of k_i is same as the value of an element k'_{i2}, where $k'_{i2} \in K'$, the PUCCH resource $n^{(1)}_{\mathrm{PUCCH},1}$ is given by $n^{(1)}_{\mathrm{PUCCH},1} = (M'-i2-1)\cdot N_c + i2\cdot N_{c+1} + n_{\mathrm{CCE},i} + N^{(1)}_{\mathrm{PUCCH}}$;

  - otherwise, if the value of k_i is same as the value of an element k^A_{i3} in set K^A, where $k^A_{i3} \in K^A$ (defined in Table 10.1.3.1-1A), the PUCCH resource $n^{(1)}_{\mathrm{PUCCH},1}$ is given by $n^{(1)}_{\mathrm{PUCCH},1} = (M^A - i3 - 1)\cdot N_c + i3\cdot N_{c+1} + n_{\mathrm{CCE},i} + N^{\mathrm{K^A}}_{\mathrm{PUCCH}}$;

  where M^A is the number of elements in the set K^A defined in Table 10.1.3.1-1A, where c is selected from {0, 1, 2, 3} such that $N_c \le n_{\mathrm{CCE},i} < N_{c+1}$, $N_c = \max\left\{0, \left\lfloor [N^{\mathrm{DL}}_{\mathrm{RB}}\cdot(N^{\mathrm{RB}}_{\mathrm{sc}}\cdot c - 4)]/36 \right\rfloor\right\}$ where $N^{\mathrm{DL}}_{\mathrm{RB}}$ is determined from the primary cell, $n_{\mathrm{CCE},i}$ is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n-k_i$, and $N^{\mathrm{K^A}}_{\mathrm{PUCCH}}$, $N^{(1)}_{\mathrm{PUCCH}}$, are configured by higher layers .

- for a PDSCH transmission on the primary cell indicated by the detection of a corresponding EPDCCH in subframe $n-k_i$, where $k_i \in K$ 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 Subclause 9.2) in subframe $n-k_i$, where $k_i \in K$ with the DAI value in the EPDCCH equal to '1', the PUCCH resource is given by

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

$$n^{(1)}_{\mathrm{PUCCH},1} = n_{\mathrm{ECCE,q}} + \sum_{i1=0}^{i4-1} N'_{ECCE,q,n-k'_{i1}} + \sum_{i1=0}^{i5-1} N'_{ECCE,q,n-k^A_{i1}} + \Delta'_{ARO} + N^{(\mathrm{e1})}_{\mathrm{PUCCH,q}}$$

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

$$n^{(1)}_{\mathrm{PUCCH},1} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N^{ECCE,q}_{RB}} \right\rfloor \cdot N^{ECCE,q}_{RB} + \sum_{i1=0}^{i4-1} N'_{ECCE,q,n-k'_{i1}} + \sum_{i1=0}^{i5-1} N'_{ECCE,q,n-k^A_{i1}} + n' + \Delta'_{ARO} + N^{(\mathrm{e1})}_{\mathrm{PUCCH,q}}$$

  where

  - if the value of k_i is same as the value of an index k'_{i2}, where $k'_{i2} \in K'$, then $i4 = i2$ and $i5 = 0$;

  - otherwise, if the value of k_i is same as the value of an index k^A_{i3}, where $k^A_{i3} \in K^A$, then $i4 = M'$ and $i5 = i3$;

  , and where $n_{\mathrm{ECCE,q}}$ 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 q in subframe $n-k_i$, $N^{(\mathrm{e1})}_{\mathrm{PUCCH,q}}$ for EPDCCH-PRB-set q is configured by the higher layer parameter *pucch-ResourceStartOffset-r11*, $N^{ECCE,q}_{RB}$ for EPDCCH-PRB-set q in subframe $n-k_i$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n-k_m$ which is described in Subclause 6.8A.5 in [3]. Δ'_{ARO}, $N'_{ECCE,q,n-k'_{i1}}$, $N'_{ECCE,q,n-k^A_{i1}}$ are determined as described in Subclause 10.1.3.1.

- HARQ-ACK(0) is the ACK/NACK/DTX response for the PDSCH transmission without a corresponding PDCCH/EPDCCH. For $1 \le j \le M-1$, if a PDSCH transmission with a corresponding PDCCH/EPDCCH and DAI value in the PDCCH/EPDCCH equal to 'j' or a PDCCH/EPDCCH indicating downlink SPS release and with DAI value in the PDCCH/EPDCCH equal to 'j' 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 $n-k_m$, where $k_m \in K$ 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$ 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 $n^{(1)}_{\mathrm{PUCCH},i} = (M_{primary}-m-1)\cdot N_c + m\cdot N_{c+1} + n_{\mathrm{CCE},m} + N^{(1)}_{\mathrm{PUCCH}}$, where c is selected from {0, 1, 2, 3} such that $N_c \le n_{\mathrm{CCE},m} < N_{c+1}$, $N_c = \max\left\{0, \left\lfloor [N^{\mathrm{DL}}_{\mathrm{RB}}\cdot(N^{\mathrm{RB}}_{\mathrm{sc}}\cdot c-4)]/36 \right\rfloor\right\}$, where $n_{\mathrm{CCE,m}}$ is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n-k_m$, $N^{(1)}_{\mathrm{PUCCH}}$ is configured by higher layers and for TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,6}, $i=0$ for the corresponding PDCCH with the DAI value equal to '1' and $i=1$ for the corresponding PDCCH with the DAI value equal to '2', and for the primary cell with TDD UL/DL configuration 0 $i=0$ 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 $n-k_m$, where $k_m \in K$ 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$ 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 k_m is same as the value of an element k'_{i2}, where $k'_{i2} \in K'$, the PUCCH resource $n^{(1)}_{\mathrm{PUCCH},i}$ is given by $n^{(1)}_{\mathrm{PUCCH},i} = (M'-i2-1)\cdot N_c + i2\cdot N_{c+1} + n_{\mathrm{CCE},m} + N^{(1)}_{\mathrm{PUCCH}}$;

    - otherwise, if the value of k_m is same as the value of an element k^A_{i3} in set K^A, where $k^A_{i3} \in K^A$ (defined in Table 10.1.3.1-1A), the PUCCH resource $n^{(1)}_{\mathrm{PUCCH},i}$ is given by $n^{(1)}_{\mathrm{PUCCH},i} = (M^A-i3-1)\cdot N_c + i3\cdot N_{c+1} + n_{\mathrm{CCE},m} + N^{\mathrm{K^A}}_{\mathrm{PUCCH}}$;

    where M^A is the number of elements in the set K^A, where c is selected from {0, 1, 2, 3} such that $N_c \le n_{\mathrm{CCE},m} < N_{c+1}$, $N_c = \max\left\{0, \left\lfloor [N^{\mathrm{DL}}_{\mathrm{RB}}\cdot(N^{\mathrm{RB}}_{\mathrm{sc}}\cdot c-4)]/36 \right\rfloor\right\}$ where $N^{\mathrm{DL}}_{\mathrm{RB}}$ is determined from the primary cell, $n_{CCE,m}$ is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n-k_m$, and $N^{\mathrm{K^A}}_{\mathrm{PUCCH}}$, $N^{(1)}_{\mathrm{PUCCH}}$, are configured by higher layers. Here, for TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,6}, $i=0$ for the corresponding PDCCH with the DAI value equal to '1' and $i=1$ for the corresponding PDCCH with the DAI value equal to '2', and for the primary cell with TDD UL/DL configuration 0 $i=0$ 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 $n-k_m$, where $k_m \in K$ 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$ 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 q is configured for distributed transmission

$$n_{\mathrm{PUCCH,i}}^{(1)} = n_{\mathrm{ECCE,q}} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

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

$$n_{\mathrm{PUCCH,i}}^{(1)} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + n' + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

where $n_{\mathrm{ECCE,q}}$ 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 q in subframe $n-k_m$, $N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$ for EPDCCH-PRB-set q is configured by the higher layer parameter *pucch-ResourceStartOffset-r11*, $N_{RB}^{ECCE,q}$ for EPDCCH-PRB-set q in subframe $n-k_m$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n-k_m$ which is described in Subclause 6.8A.5 in [3]. If $m=0$, Δ_{ARO} 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 $m>0$, Δ_{ARO} 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 $n-k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs in EPDCCH-PRB-set q configured for that UE in subframe $n-k_{i1}$. If the UE is not configured to monitor EPDCCH in subframe $n-k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs computed assuming EPDCCH-PRB-set q is configured for that UE in subframe $n-k_{i1}$. For normal downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 5, $N_{ECCE,q,n-k_{i1}}$ is equal to 0. For extended downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 4 or 7, $N_{ECCE,q,n-k_{i1}}$ is equal to 0. Here, for TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,6} $i=0$ for the corresponding EPDCCH with the DAI value equal to '1' and $i=1$ for the corresponding EPDCCH with the DAI value equal to '2', and for the primary cell with TDD UL/DL configuration 0 $i=0$ 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 $n-k_m$, where $k_m \in K$ 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$ 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 q is configured for distributed transmission

$$n_{\mathrm{PUCCH,i}}^{(1)} = n_{\mathrm{ECCE,q}} + \sum_{i1=0}^{i4-1} N_{ECCE,q,n-k'_{i1}} + \sum_{i1=0}^{i5-1} N_{ECCE,q,n-k_{i1}^{A}} + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

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

$$n_{\mathrm{PUCCH,i}}^{(1)} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + \sum_{i1=0}^{i4-1} N_{ECCE,q,n-k'_{i1}} + \sum_{i1=0}^{i5-1} N_{ECCE,q,n-k_{i1}^{A}} + n' + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

where

- if the value of k_m is same as the value of an index k'_{i2}, where $k'_{i2} \in K'$, then $i4 = i2$;
- otherwise, if the value of k_m is same as the value of an index k_{i3}^{A}, where $k_{i3}^{A} \in K^{A}$, then $i4 = i3$;

, and where $n_{\mathrm{ECCE,q}}$ 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 q in subframe $n-k_m$, $N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$ for EPDCCH-PRB-set q is configured by the higher layer parameter *pucch-ResourceStartOffset-r11* , $N_{RB}^{ECCE,q}$ for EPDCCH-PRB-set q in subframe $n-k_m$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n-k_m$ which is described in Subclause 6.8A.5 in [3].. Δ'_{ARO}, $N_{ECCE,q,n-k'_{i1}}$, $N_{ECCE,q,n-k_{i1}^{A}}$ are determined as described in Subclause 10.1.3.1. Here, for TDD UL/DL configuration of the primary cell belonging to {1,2,3,4,6} $i=0$ for the corresponding EPDCCH with the DAI value equal to '1' and $i=1$ for the corresponding EPDCCH with the DAI value equal to '2', and for the primary cell with TDD UL/DL configuration 0 $i=0$ for the corresponding EPDCCH.

- For $0 \le j \le M-1$ 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 '$j+1$' or a PDCCH/EPDCCH indicating downlink SPS release and with DAI value in the PDCCH/EPDCCH equal to '$j+1$' is received, HARQ-ACK(j) is the corresponding ACK/NACK/DTX response; otherwise HARQ-ACK(j) shall be set to DTX. For $0 \le j \le M-1$ 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 $n-k_m$, where $k_m \in K$ with the DAI value in the PDCCH equal to either '1' or '2', the PUCCH resources $n_{\mathrm{PUCCH},i}^{(1)} = (M_{primary} - m - 1) \cdot N_c + m \cdot N_{c+1} + n_{\mathrm{CCE},m} + N_{\mathrm{PUCCH}}^{(1)}$, where c is selected from {0, 1, 2, 3} such that $N_c \le n_{\mathrm{CCE,m}} < N_{c+1}$, $N_c = \max\left\{0, \left\lfloor [N_{\mathrm{RB}}^{\mathrm{DL}} \cdot (N_{\mathrm{sc}}^{\mathrm{RB}} \cdot c - 4)]/36 \right\rfloor\right\}$, where $N_{\mathrm{RB}}^{\mathrm{DL}}$ is determined from the primary cell, $n_{\mathrm{CCE,m}}$ is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n-k_m$, $N_{\mathrm{PUCCH}}^{(1)}$ is configured by higher layers, $i=2$ for the corresponding PDCCH with the DAI value equal to '1' and $i=3$ 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 $n-k_m$, where $k_m \in K$ with the DAI value in the PDCCH equal to either '1' or '2',
  - if the value of k_m is same as the value of an element k'_{i2}, where $k'_{i2} \in K'$, the PUCCH resource $n_{\mathrm{PUCCH},i}^{(1)}$ is given by $n_{\mathrm{PUCCH},i}^{(1)} = (M' - i2 - 1) \cdot N_c + i2 \cdot N_{c+1} + n_{\mathrm{CCE},m} + N_{\mathrm{PUCCH}}^{(1)}$;
  - otherwise, if the value of k_m is same as the value of an element k_{i3}^{A} in set K^{A}, where $k_{i3}^{A} \in K^{A}$(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 $n^{(1)}_{\text{PUCCH},i}$ is given by

$$n^{(1)}_{\text{PUCCH},i} = (M^A - i3 - 1)\cdot N_c + i3\cdot N_{c+1} + n_{\text{CCE},m} + N^{\text{K}^\text{A}}_{\text{PUCCH}};$$

where M^A is the number of elements in the set K^A defined in Table 10.1.3.1-1A , where c is selected from {0, 1, 2, 3} such that $N_c \le n_{\text{CCE},m} < N_{c+1}$, $N_c = \max\left\{0, \left\lfloor [N^{\text{DL}}_{\text{RB}}\cdot(N^{\text{RB}}_{\text{sc}}\cdot c - 4)]/36 \right\rfloor\right\}$ where $N^{\text{DL}}_{\text{RB}}$ is determined from the primary cell, $n_{CCE,m}$ is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n-k_m$, and $N^{\text{K}^\text{A}}_{\text{PUCCH}}$, $N^{(1)}_{\text{PUCCH}}$, are configured by higher layers. Here, $i=2$ for the corresponding PDCCH with the DAI value equal to '1' and $i=3$ 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 $n-k_m$, where $k_m \in K$ with the DAI value in the PDCCH equal to either '1' or '2', the PUCCH resources are given by
  - If EPDCCH-PRB-set q is configured for distributed transmission

$$n^{(1)}_{\text{PUCCH,i}} = n_{\text{ECCE,q}} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + \Delta_{ARO} + N^{(\text{e1})}_{\text{PUCCH,q}}$$

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

$$n^{(1)}_{\text{PUCCH,i}} = \left\lfloor \frac{n_{\text{ECCE,q}}}{N^{ECCE,q}_{RB}} \right\rfloor \cdot N^{ECCE,q}_{RB} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + n' + \Delta_{ARO} + N^{(\text{e1})}_{\text{PUCCH,q}}$$

where $n_{\text{ECCE,q}}$ 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 q in subframe $n-k_m$, $N^{(\text{e1})}_{\text{PUCCH,q}}$ for EPDCCH-PRB-set q is configured by the higher layer parameter *pucch-ResourceStartOffset-r11* , $N^{ECCE,q}_{RB}$ for EPDCCH-PRB-set q in subframe $n-k_m$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n-k_m$ which is described in Subclause 6.8A.5 in [3]. If $m=0$, Δ_{ARO} 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 $m>0$, Δ_{ARO} 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 $n-k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs in EPDCCH-PRB-set q configured for that UE in subframe $n-k_{i1}$. If the UE is not configured to monitor EPDCCH in subframe $n-k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs computed assuming EPDCCH-PRB-set q is configured for that UE in subframe $n-k_{i1}$. For normal downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 5, $N_{ECCE,q,n-k_{i1}}$ is equal to 0. For extended downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 4 or 7, $N_{ECCE,q,n-k_{i1}}$ is equal to 0. Here, $i=2$ for the corresponding EPDCCH with the DAI value equal to '1' and $i=3$ 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 $n-k_m$, where $k_m \in K$ with the DAI value in the PDCCH equal to either '1' or '2', the PUCCH resources are given by
  - If EPDCCH-PRB-set q is configured for distributed transmission

$$n_{\mathrm{PUCCH,i}}^{(1)} = n_{\mathrm{ECCE,q}} + \sum_{i1=0}^{i4-1} N'_{ECCE,q,n-k'_{i1}} + \sum_{i1=0}^{i5-1} N'_{ECCE,q,n-k_{i1}^{A}} + \Delta'_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

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

$$n_{\mathrm{PUCCH,i}}^{(1)} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + \sum_{i1=0}^{i4-1} N'_{ECCE,q,n-k'_{i1}} + \sum_{i1=0}^{i5-1} N'_{ECCE,q,n-k_{i1}^{A}} + n' + \Delta'_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

where

- if the value of k_m is same as the value of an index k'_{i2}, where $k'_{i2} \in K'$, then $i4 = i2$;
- otherwise, if the value of k_m is same as the value of an index k_{i3}^{A}, where $k_{i3}^{A} \in K^{A}$, then $i4 = i3$;

and where $n_{\mathrm{ECCE,q}}$ 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 q in subframe $n-k_m$, $N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$ for EPDCCH-PRB-set q is configured by the higher layer parameter *pucch-ResourceStartOffset-r11*, $N_{RB}^{ECCE,q}$ for EPDCCH-PRB-set q in subframe $n-k_m$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n-k_m$ which is described in Subclause 6.8A.5 in [3]. Δ'_{ARO}, $N'_{ECCE,q,n-k'_{i1}}$, $N'_{ECCE,q,n-k_{i1}^{A}}$ are determined as described in Subclause 10.1.3.1. For extended downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 4 or 7, $N_{ECCE,q,n-k_{i1}}$ is equal to 0. Here, $i=2$ for the corresponding EPDCCH with the DAI value equal to '1' and $i=3$ 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) $n-k$, where $k \in K$ on the secondary cell, the value of $n_{\mathrm{PUCCH,2}}^{(1)}$ and $n_{\mathrm{PUCCH,3}}^{(1)}$ 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) $n-k$, where $k \in K$.
- For $0 \le j \le M-1$, if a PDSCH transmission with a corresponding PDCCH/EPDCCH and DAI value in the PDCCH/EPDCCH equal to '$j+1$' 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 $b(0), b(1)$ on PUCCH resource $n_{\mathrm{PUCCH}}^{(1,\tilde{p})}$ for $\tilde{p}$ mapped to antenna port *p* using PUCCH format 1b according to Subclause 5.4.1 in [3] where

- $n_{\mathrm{PUCCH}}^{(1,\tilde{p}_0)} = n_{\mathrm{PUCCH}}^{(1)}$ in sub-frame n for $\tilde{p}$ mapped to antenna port p_0 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 $b(0), b(1)$ and the PUCCH resource $n_{\mathrm{PUCCH}}^{(1)}$ 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.
- $n_{\mathrm{PUCCH}}^{(1,\tilde{p}_1)}$ for antenna port p_1, where $n_{\mathrm{PUCCH}}^{(1,\tilde{p}_1)}$ selected from PUCCH resources, $n_{\mathrm{PUCCH},i}^{(1,\tilde{p}_1)}$ configured by higher layers where $0 \le i \le 3$ according Tables 10.1.3.2-5, and 10.1.3.2-6 for *M* = 3, and 4 respectively by replacing $n_{\mathrm{PUCCH}}^{(1)}$ with $n_{\mathrm{PUCCH}}^{(1,\tilde{p}_1)}$ and replacing $n_{\mathrm{PUCCH},i}^{(1)}$ with $n_{\mathrm{PUCCH},i}^{(1,\tilde{p}_1)}$, 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)	$n^{(1)}_{\text{PUCCH}}$	$b(0), b(1)$	$o(0), o(1), o(2), o(3)$
ACK, ACK, ACK	ACK, ACK, ACK	$n^{(1)}_{\text{PUCCH},1}$	1, 1	1,1,1,1
ACK, ACK, NACK/DTX	ACK, ACK, ACK	$n^{(1)}_{\text{PUCCH},1}$	0, 0	1,0,1,1
ACK, NACK/DTX, any	ACK, ACK, ACK	$n^{(1)}_{\text{PUCCH},3}$	1, 1	0,1,1,1
NACK/DTX, any, any	ACK, ACK, ACK	$n^{(1)}_{\text{PUCCH},3}$	0, 1	0,0,1,1
ACK, ACK, ACK	ACK, ACK, NACK/DTX	$n^{(1)}_{\text{PUCCH},0}$	1, 0	1,1,1,0
ACK, ACK, NACK/DTX	ACK, ACK, NACK/DTX	$n^{(1)}_{\text{PUCCH},3}$	1, 0	1,0,1,0
ACK, NACK/DTX, any	ACK, ACK, NACK/DTX	$n^{(1)}_{\text{PUCCH},0}$	0, 1	0,1,1,0
NACK/DTX, any, any	ACK, ACK, NACK/DTX	$n^{(1)}_{\text{PUCCH},3}$	0, 0	0,0,1,0
ACK, ACK, ACK	ACK, NACK/DTX, any	$n^{(1)}_{\text{PUCCH},2}$	1, 1	1, 1, 0, 1
ACK, ACK, NACK/DTX	ACK, NACK/DTX, any	$n^{(1)}_{\text{PUCCH},2}$	0, 1	1, 0, 0, 1
ACK, NACK/DTX, any	ACK, NACK/DTX, any	$n^{(1)}_{\text{PUCCH},2}$	1, 0	0, 1, 0, 1
NACK/DTX, any, any	ACK, NACK/DTX, any	$n^{(1)}_{\text{PUCCH},2}$	0, 0	0, 0, 0, 1
ACK, ACK, ACK	NACK/DTX, any, any	$n^{(1)}_{\text{PUCCH},1}$	1, 0	1, 1, 0, 0
ACK, ACK, NACK/DTX	NACK/DTX, any, any	$n^{(1)}_{\text{PUCCH},1}$	0, 1	1, 0, 0, 0
ACK, NACK/DTX, any	NACK/DTX, any, any	$n^{(1)}_{\text{PUCCH},0}$	1, 1	0, 1, 0, 0
NACK, any, any	NACK/DTX, any, any	$n^{(1)}_{\text{PUCCH},0}$	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)	$n^{(1)}_{\text{PUCCH}}$	$b(0), b(1)$	$o(0), o(1), o(2), o(3)$
ACK, ACK, ACK, NACK/DTX	ACK, ACK, ACK, NACK/DTX	$n^{(1)}_{\text{PUCCH},1}$	1, 1	1, 1, 1, 1
ACK, ACK, NACK/DTX, any	ACK, ACK, ACK, NACK/DTX	$n^{(1)}_{\text{PUCCH},1}$	0, 0	1, 0, 1, 1
ACK, DTX, DTX, DTX	ACK, ACK, ACK, NACK/DTX	$n^{(1)}_{\text{PUCCH},3}$	1, 1	0, 1, 1, 1
ACK, ACK, ACK, ACK	ACK, ACK, ACK, NACK/DTX	$n^{(1)}_{\text{PUCCH},3}$	1, 1	0, 1, 1, 1
NACK/DTX, any, any, any	ACK, ACK, ACK, NACK/DTX	$n^{(1)}_{\text{PUCCH},3}$	0, 1	0, 0, 1, 1
(ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX)	ACK, ACK, ACK, NACK/DTX	$n^{(1)}_{\text{PUCCH},3}$	0, 1	0, 0, 1, 1
ACK, ACK, ACK, NACK/DTX	ACK, ACK, NACK/DTX, any	$n^{(1)}_{\text{PUCCH},0}$	1, 0	1, 1, 1, 0
ACK, ACK, NACK/DTX, any	ACK, ACK, NACK/DTX, any	$n^{(1)}_{\text{PUCCH},3}$	1, 0	1, 0, 1, 0
ACK, DTX, DTX, DTX	ACK, ACK, NACK/DTX, any	$n^{(1)}_{\text{PUCCH},0}$	0, 1	0, 1, 1, 0
ACK, ACK, ACK, ACK	ACK, ACK, NACK/DTX, any	$n^{(1)}_{\text{PUCCH},0}$	0, 1	0, 1, 1, 0
NACK/DTX, any, any, any	ACK, ACK, NACK/DTX, any	$n^{(1)}_{\text{PUCCH},3}$	0, 0	0, 0, 1, 0
(ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX)	ACK, ACK, NACK/DTX, any	$n^{(1)}_{\text{PUCCH},3}$	0, 0	0, 0, 1, 0
ACK, ACK, ACK, NACK/DTX	ACK, DTX, DTX, DTX	$n^{(1)}_{\text{PUCCH},2}$	1, 1	1, 1, 0, 1
ACK, ACK, ACK, NACK/DTX	ACK, ACK, ACK, ACK	$n^{(1)}_{\text{PUCCH},2}$	1, 1	1, 1, 0, 1
ACK, ACK, NACK/DTX, any	ACK, DTX, DTX, DTX	$n^{(1)}_{\text{PUCCH},2}$	0, 1	1, 0, 0, 1
ACK, ACK, NACK/DTX, any	ACK, ACK, ACK, ACK	$n^{(1)}_{\text{PUCCH},2}$	0, 1	1, 0, 0, 1
ACK, DTX, DTX, DTX	ACK, DTX, DTX, DTX	$n^{(1)}_{\text{PUCCH},2}$	1, 0	0, 1, 0, 1
ACK, DTX, DTX, DTX	ACK, ACK, ACK, ACK	$n^{(1)}_{\text{PUCCH},2}$	1, 0	0, 1, 0, 1
ACK, ACK, ACK, ACK	ACK, DTX, DTX, DTX	$n^{(1)}_{\text{PUCCH},2}$	1, 0	0, 1, 0, 1
ACK, ACK, ACK, ACK	ACK, ACK, ACK, ACK	$n^{(1)}_{\text{PUCCH},2}$	1, 0	0, 1, 0, 1
NACK/DTX, any, any, any	ACK, DTX, DTX, DTX	$n^{(1)}_{\text{PUCCH},2}$	0, 0	0, 0, 0, 1
NACK/DTX, any, any, any	ACK, ACK, ACK, ACK	$n^{(1)}_{\text{PUCCH},2}$	0, 0	0, 0, 0, 1
(ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX)	ACK, DTX, DTX, DTX	$n^{(1)}_{\text{PUCCH},2}$	0, 0	0, 0, 0, 1
(ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX)	ACK, ACK, ACK, ACK	$n^{(1)}_{\text{PUCCH},2}$	0, 0	0, 0, 0, 1
ACK, ACK, ACK, NACK/DTX	NACK/DTX, any, any, any	$n^{(1)}_{\text{PUCCH},1}$	1, 0	1, 1, 0, 0
ACK, ACK, ACK, NACK/DTX	(ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX)	$n^{(1)}_{\text{PUCCH},1}$	1, 0	1, 1, 0, 0
ACK, ACK, NACK/DTX, any	NACK/DTX, any, any, any	$n^{(1)}_{\text{PUCCH},1}$	0, 1	1, 0, 0, 0
ACK, ACK, NACK/DTX, any	(ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX)	$n^{(1)}_{\text{PUCCH},1}$	0, 1	1, 0, 0, 0

ACK, DTX, DTX, DTX	NACK/DTX, any, any, any	$n^{(1)}_{\mathrm{PUCCH},0}$	1, 1	0, 1, 0, 0
ACK, DTX, DTX, DTX	(ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX)	$n^{(1)}_{\mathrm{PUCCH},0}$	1, 1	0, 1, 0, 0
ACK, ACK, ACK, ACK	NACK/DTX, any, any, any	$n^{(1)}_{\mathrm{PUCCH},0}$	1, 1	0, 1, 0, 0
ACK, ACK, ACK, ACK	(ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX)	$n^{(1)}_{\mathrm{PUCCH},0}$	1, 1	0, 1, 0, 0
NACK, any, any, any	NACK/DTX, any, any, any	$n^{(1)}_{\mathrm{PUCCH},0}$	0, 0	0, 0, 0, 0
NACK, any, any, any	(ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX)	$n^{(1)}_{\mathrm{PUCCH},0}$	0, 0	0, 0, 0, 0
(ACK, NACK/DTX, any, any), except for (ACK, DTX, DTX, DTX)	NACK/DTX, any, any, any	$n^{(1)}_{\mathrm{PUCCH},0}$	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)	$n^{(1)}_{\mathrm{PUCCH},0}$	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 $K' = K$ where the set K is defined in Table 10.1.3.1-1 (where "UL/DL configuration" in the table refers to the higher layer parameter *subframeAssignment*), and M' is the number of elements in set K'.

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 Subclause K is as defined in Sec 10.2, and M is the number of elements in the set K.

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

For TDD HARQ-ACK transmission with PUCCH format 3 and sub-frame n with $M \geq 1$ and more than one configured serving cell, where M is the number of elements in the set K, the UE shall use PUCCH resource $n_{\text{PUCCH}}^{(3,\tilde{p})}$ or $n_{\text{PUCCH}}^{(1,\tilde{p})}$ for transmission of HARQ-ACK in subframe n for $\tilde{p}$ 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 $n-k_m$, where $k_m \in K$, 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$, 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 $n_{\text{PUCCH}}^{(1,\tilde{p})}$ with $n_{\text{PUCCH}}^{(1,\tilde{p}_0)} = (M-m-1)\cdot N_c + m\cdot N_{c+1} + n_{\text{CCE},m} + N_{\text{PUCCH}}^{(1)}$ for antenna port p_0, where $N_{\text{PUCCH}}^{(1)}$ is configured by higher layers, c is selected from {0, 1, 2, 3} such that $N_c \leq n_{\text{CCE},m} < N_{c+1}$, $N_c = \max\left\{0, \left\lfloor [N_{\text{RB}}^{\text{DL}} \cdot (N_{\text{sc}}^{\text{RB}} \cdot c - 4)]/36 \right\rfloor\right\}$, and $n_{\text{CCE,m}}$ is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n-k_m$ where $k_m \in K$. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port p_1 is given by $n_{\text{PUCCH}}^{(1,\tilde{p}_1)} = n_{\text{PUCCH}}^{(1,\tilde{p}_0)} + 1$
- 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 $n-k_m$, where $k_m \in K$, 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$, 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 k_m is same as the value of an element k'_{i2}, where $k'_{i2} \in K'$, the PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p})}$ is given by $n_{\text{PUCCH}}^{(1,\tilde{p})} = (M'-i2-1)\cdot N_c + i2\cdot N_{c+1} + n_{\text{CCE},m} + N_{\text{PUCCH}}^{(1)}$;
      - otherwise, if the value of k_m is same as the value of an element k_{i3}^A in set K^A, where $k_{i3}^A \in K^A$ (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 $n_{\mathrm{PUCCH}}^{(1,\tilde{p})}$ is given by

$n_{\mathrm{PUCCH}}^{(1,\tilde{p})} = (M^A - i3 - 1)\cdot N_c + i3\cdot N_{c+1} + n_{\mathrm{CCE},m} + N_{\mathrm{PUCCH}}^{\mathrm{K^A}}$;

where M^A is the number of elements in the set K^A defined in Table 10.1.3.1-1A , where c is selected from {0, 1, 2, 3} such that $N_c \le n_{\mathrm{CCE},m} < N_{c+1}$,

$N_c = \max\left\{0, \left\lfloor [N_{\mathrm{RB}}^{\mathrm{DL}}\cdot(N_{\mathrm{sc}}^{\mathrm{RB}}\cdot c - 4)]/36 \right\rfloor\right\}$ where $N_{\mathrm{RB}}^{\mathrm{DL}}$ is determined from the primary cell, $n_{CCE,m}$ is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n-k_m$, and $N_{\mathrm{PUCCH}}^{\mathrm{K^A}}$, $N_{\mathrm{PUCCH}}^{(1)}$, are configured by higher layers. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port p_1 is given by $n_{\mathrm{PUCCH}}^{(1,\tilde{p}_1)} = n_{\mathrm{PUCCH}}^{(1,\tilde{p}_0)} + 1$

- 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 $n-k_m$, where $k_m \in K$, 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$, 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 $n_{\mathrm{PUCCH}}^{(1,\tilde{p})}$ given by
      - If EPDCCH-PRB-set q is configured for distributed transmission

$$n_{\mathrm{PUCCH}}^{(1,\tilde{p})} = n_{\mathrm{ECCE,q}} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

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

$$n_{\mathrm{PUCCH}}^{(1,\tilde{p})} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + n' + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

where $n_{\mathrm{ECCE,q}}$ 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 q in subframe $n-k_m$, $N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$ for EPDCCH-PRB-set q is configured by the higher layer parameter pucch-ResourceStartOffset-r11 , $N_{RB}^{ECCE,q}$ for EPDCCH-PRB-set q in subframe $n-k_m$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n-k_m$ which is described in Subclause 6.8A.5 in [3]. If $m=0$, Δ_{ARO} 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 $m>0$, Δ_{ARO} 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 $n-k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs in EPDCCH-PRB-set q configured for that UE in subframe $n-k_{i1}$. If the UE is not configured to monitor EPDCCH in subframe $n-k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs computed assuming EPDCCH-PRB-set q is configured for that UE in subframe $n-k_{i1}$. For normal downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 5,

$N_{ECCE,q,n-k_{i1}}$ is equal to 0. For extended downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 4 or 7, $N_{ECCE,q,n-k_{i1}}$ is equal to 0. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port p_1 is given by $n_{\mathrm{PUCCH}}^{(1,\tilde{p}_1)} = n_{\mathrm{PUCCH}}^{(1,\tilde{p}_0)} + 1$.

- 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 $n-k_m$, where $k_m \in K$, 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$, 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 $n_{\mathrm{PUCCH}}^{(1,\tilde{p})}$ given by
      - if EPDCCH-PRB-set q is configured for distributed transmission

$$n_{\mathrm{PUCCH}}^{(1,\tilde{p})} = n_{\mathrm{ECCE,q}} + \sum_{i1=0}^{i4-1} N'_{ECCE,q,n-k'_{i1}} + \sum_{i1=0}^{i5-1} N'_{ECCE,q,n-k_{i1}^{A}} + \Delta'_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

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

$$n_{\mathrm{PUCCH}}^{(1,\tilde{p})} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + \sum_{i1=0}^{i4-1} N'_{ECCE,q,n-k'_{i1}} + \sum_{i1=0}^{i5-1} N'_{ECCE,q,n-k_{i1}^{A}} + n' + \Delta'_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

        where
        - if the value of k_m is same as the value of an index k'_{i2}, where $k'_{i2} \in K'$, then $i4 = i2$;
        - otherwise, if the value of k_m is same as the value of an index k_{i3}^{A}, where $k_{i3}^{A} \in K^{A}$, then $i4 = i3$;

        and where $n_{\mathrm{ECCE,q}}$ 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 q in subframe $n-k_m$, $N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$ for EPDCCH-PRB-set q is configured by the higher layer parameter *pucch-ResourceStartOffset-r11*, $N_{RB}^{ECCE,q}$ for EPDCCH-PRB-set q in subframe $n-k_m$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n-k_m$ which is described in Subclause 6.8A.5 in [3]. Δ'_{ARO}, $N'_{ECCE,q,n-k'_{i1}}$, $N'_{ECCE,q,n-k_{i1}^{A}}$ are determined as described in Subclause 10.1.3.1. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port p_1 is given by $n_{\mathrm{PUCCH}}^{(1,\tilde{p}_1)} = n_{\mathrm{PUCCH}}^{(1,\tilde{p}_0)} + 1$.

- for a single PDSCH transmission only on the primary cell where there is not a corresponding PDCCH/EPDCCH detected within subframe(s) $n-k$, where $k \in K$ and no PDCCH/EPDCCH indicating downlink SPS release (defined in Subclause 9.2) within subframe(s) $n-k$, where $k \in K$, the UE shall use PUCCH format 1a/1b and PUCCH resource $n_{\mathrm{PUCCH}}^{(1,\tilde{p})}$ with the value of $n_{\mathrm{PUCCH}}^{(1,\tilde{p})}$ 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 $n_{\mathrm{PUCCH}}^{(1,\tilde{p}_0)}$ for

antenna port p_0 and the second PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p}_1)}$ for antenna port p_1, otherwise, the PUCCH resource value maps to a single PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p}_0)}$ for antenna port p_0.

- for $M > 1$, and
  - for a PDSCH transmission only on the primary cell where there is not a corresponding PDCCH detected within subframe(s) $n-k$, where $k \in K$, and
    - for an additional PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe $n-k_m$, where $k_m \in K$ 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$ with the DAI value in the PDCCH equal to '1',
      - the UE shall transmit $b(0), b(1)$ in subframe n using PUCCH format 1b on PUCCH resource $n_{\text{PUCCH}}^{(1)}$ selected from A PUCCH resources $n_{\text{PUCCH},i}^{(1)}$ where $0 \le i \le A-1$, according to Table 10.1.3.2-1 and Table 10.1.3.2-2 for $A=2$ and $A=3$, respectively. For a UE configured with a transmission mode that supports up to two transport blocks on the primary cell, $A=3$; otherwise, $A=2$.
        - If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource $n_{\text{PUCCH},0}^{(1)}$ is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource $n_{\text{PUCCH},1}^{(1)}$ is determined as $n_{\text{PUCCH},1}^{(1)} = (M-m-1)\cdot N_c + m\cdot N_{c+1} + n_{\text{CCE},m} + N_{\text{PUCCH}}^{(1)}$, where $N_{\text{PUCCH}}^{(1)}$ is configured by higher layers, c is selected from {0, 1, 2, 3} such that $N_c \le n_{\text{CCE},m} < N_{c+1}$, $N_c = \max\left\{0, \left\lfloor [N_{\text{RB}}^{\text{DL}} \cdot (N_{\text{sc}}^{\text{RB}} \cdot c - 4)]/36 \right\rfloor\right\}$, and $n_{\text{CCE,m}}$ is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n-k_m$ where $k_m \in K$.
        - If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource $n_{\text{PUCCH},0}^{(1)}$ is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource $n_{\text{PUCCH},1}^{(1)}$ is determined as
          - if the value of k_m is same as the value of an element k'_{i2}, where $k'_{i2} \in K'$, the PUCCH resource $n_{\text{PUCCH},1}^{(1)}$ is given by $n_{\text{PUCCH},1}^{(1)} = (M'-i2-1)\cdot N_c + i2\cdot N_{c+1} + n_{\text{CCE},m} + N_{\text{PUCCH}}^{(1)}$;
          - otherwise, if the value of k_m is same as the value of an element k_{i3}^{A} in set K^A, where $k_{i3}^{A} \in K^A$ (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 $n_{\text{PUCCH},1}^{(1)}$ is given by $n_{\text{PUCCH},1}^{(1)} = (M^A - i3 - 1)\cdot N_c + i3\cdot N_{c+1} + n_{\text{CCE},m} + N_{\text{PUCCH}}^{\text{K}^{\text{A}}}$;

            where M^A is the number of elements in the set K^A defined in Table 10.1.3.1-1A , where c is selected from {0, 1, 2, 3} such that $N_c \le n_{\text{CCE},m} < N_{c+1}$, $N_c = \max\left\{0, \left\lfloor [N_{\text{RB}}^{\text{DL}} \cdot (N_{\text{sc}}^{\text{RB}} \cdot c - 4)]/36 \right\rfloor\right\}$, $n_{CCE,m}$ is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n-k_m$, and $N_{\text{PUCCH}}^{\text{K}^{\text{A}}}$, $N_{\text{PUCCH}}^{(1)}$, 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 $n^{(1)}_{\text{PUCCH},2}$ is determined as $n^{(1)}_{\text{PUCCH},2} = n^{(1)}_{\text{PUCCH},1} + 1$.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 $M > 1$, and
  - for a PDSCH transmission only on the primary cell where there is not a corresponding EPDCCH detected within subframe(s) $n-k$, where $k \in K$, and
    - for an additional PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe $n-k_m$, where $k_m \in K$ 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$ with the DAI value in the EPDCCH equal to '1',
      - the UE shall transmit $b(0), b(1)$ in subframe n using PUCCH format 1b on PUCCH resource $n^{(1)}_{\text{PUCCH}}$ selected from A PUCCH resources $n^{(1)}_{\text{PUCCH},i}$ where $0 \le i \le A-1$, according to Table 10.1.3.2-1 and Table 10.1.3.2-2 for $A=2$ and $A=3$, respectively. For a UE configured with a transmission mode that supports up to two transport blocks on the primary cell, $A=3$; otherwise, $A=2$.
        - If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource $n^{(1)}_{\text{PUCCH},0}$ is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource $n^{(1)}_{\text{PUCCH},1}$ is determined as
          - If EPDCCH-PRB-set q is configured for distributed transmission

$$n^{(1)}_{\text{PUCCH},1} = n_{\text{ECCE,q}} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + \Delta_{ARO} + N^{(\text{e1})}_{\text{PUCCH,q}}$$

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

$$n^{(1)}_{\text{PUCCH},1} = \left\lfloor \frac{n_{\text{ECCE,q}}}{N^{ECCE,q}_{RB}} \right\rfloor \cdot N^{ECCE,q}_{RB} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + n' + \Delta_{ARO} + N^{(\text{e1})}_{\text{PUCCH,q}}$$

            where $n_{\text{ECCE,q}}$ 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 q in subframe $n-k_m$, $N^{(\text{e1})}_{\text{PUCCH,q}}$ for EPDCCH-PRB-set q is configured by the higher layer parameter pucch-ResourceStartOffset-r11 , $N^{ECCE,q}_{RB}$ for EPDCCH-PRB-set q in subframe $n-k_m$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n-k_m$ which is described in Subclause 6.8A.5 in [3]. If $m=0$, Δ_{ARO} 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 $m>0$, Δ_{ARO} 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 $n-k_{i1}$,

$N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs in EPDCCH-PRB-set q configured for that UE in subframe $n-k_{i1}$. If the UE is not configured to monitor EPDCCH in subframe $n-k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs computed assuming EPDCCH-PRB-set q is configured for that UE in subframe $n-k_{i1}$. For normal downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 5, $N_{ECCE,q,n-k_{i1}}$ is equal to 0. For extended downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 4 or 7, $N_{ECCE,q,n-k_{i1}}$ is equal to 0.

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource $n^{(1)}_{\text{PUCCH},0}$ is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource $n^{(1)}_{\text{PUCCH},1}$ is determined as

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

$$n^{(1)}_{\text{PUCCH,i}} = n_{\text{ECCE,q}} + \sum_{i1=0}^{i4-1} N'_{ECCE,q,n-k'_{i1}} + \sum_{i1=0}^{i5-1} N'_{ECCE,q,n-k^{A}_{i1}} + \Delta'_{ARO} + N^{(\text{e1})}_{\text{PUCCH,q}}$$

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

$$n^{(1)}_{\text{PUCCH,i}} = \left\lfloor \frac{n_{\text{ECCE,q}}}{N^{ECCE,q}_{RB}} \right\rfloor \cdot N^{ECCE,q}_{RB} + \sum_{i1=0}^{i4-1} N'_{ECCE,q,n-k'_{i1}} + \sum_{i1=0}^{i5-1} N'_{ECCE,q,n-k^{A}_{i1}} + n' + \Delta'_{ARO} + N^{(\text{e1})}_{\text{PUCCH,q}}$$

    where

    - if the value of k_m is same as the value of an index k'_{i2}, where $k'_{i2} \in K'$, then $i4 = i2$;
    - otherwise, if the value of k_m is same as the value of an index k^{A}_{i3}, where $k^{A}_{i3} \in K^{A}$, then $i4 = i3$;

  - and where $n_{\text{ECCE,q}}$ 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 q in subframe $n-k_m$, $N^{(\text{e1})}_{\text{PUCCH,q}}$ for EPDCCH-PRB-set q is configured by the higher layer parameter *pucch-ResourceStartOffset-r11* , $N^{ECCE,q}_{RB}$ for EPDCCH-PRB-set q in subframe $n-k_m$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n-k_m$ which is described in Subclause 6.8A.5 in [3]. Δ'_{ARO}, $N'_{ECCE,q,n-k'_{i1}}$, $N'_{ECCE,q,n-k^{A}_{i1}}$ are determined as described in Subclause 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 $n^{(1)}_{\text{PUCCH},2}$ is determined as $n^{(1)}_{\text{PUCCH},2} = n^{(1)}_{\text{PUCCH},1} + 1$.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 $M > 1$, and

- for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe $n-k_m$, where $k_m \in K$ 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$ with the DAI value in the PDCCH greater than '1', or
- for $M=9$ and for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe $n-k_m$, where $k_m \in K$ 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) $n-k$, where $k \in K$ with the DAI value equal to '1', or
- for $M=9$ and for a PDCCH indicating downlink SPS release (defined in Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$ 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) $n-k$, where $k \in K$ with the DAI value equal to '1',
  - the UE shall use PUCCH format 3 and PUCCH resource $n_{\mathrm{PUCCH}}^{(3,\tilde{p})}$ where the value of $n_{\mathrm{PUCCH}}^{(3,\tilde{p})}$ 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) $n-k$, where $k \in K$ 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) $n-k$, where $k \in K$.

- for $M>1$, and
  - for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe $n-k_m$, where $k_m \in K$ 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$ with the DAI value in the EPDCCH greater than '1', or
  - for $M=9$ and for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe $n-k_m$, where $k_m \in K$ 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) $n-k$, where $k \in K$ with the DAI value equal to '1', or
  - for $M=9$ and for an EPDCCH indicating downlink SPS release (defined in Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$ 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) $n-k$, where $k \in K$ with the DAI value equal to '1',
    - the UE shall use PUCCH format 3 and PUCCH resource $n_{\mathrm{PUCCH}}^{(3,\tilde{p})}$ where the value of $n_{\mathrm{PUCCH}}^{(3,\tilde{p})}$ 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) $n-k$, where $k \in K$ 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) $n-k$, where $k \in K$.

- 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) $n-k$, where $k \in K$, the UE shall use PUCCH format 3 and PUCCH resource $n_{\mathrm{PUCCH}}^{(3,\tilde{p})}$ where the value of $n_{\mathrm{PUCCH}}^{(3,\tilde{p})}$ 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) $n-k$, where $k \in K$, or a PDCCH indicating downlink SPS release (defined in Subclause 9.2) within subframe(s) $n-k$, where $k \in K$, 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) $n-k$, where $k \in K$ 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) $n-k$, where $k \in K$. For TDD UL/DL configurations 1-6, if an EPDCCH corresponding to a PDSCH on the primary cell within subframe(s) $n-k$, where $k \in K$, or an EPDCCH indicating downlink SPS release (defined in Subclause 9.2) within subframe(s) $n-k$, where $k \in K$, 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) $n-k$, where $k \in K$ 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) $n-k$, where $k \in K$.

- 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) $n-k$, where $k \in K$, the UE shall use PUCCH format 3 and PUCCH resource $n_{\mathrm{PUCCH}}^{(3,\tilde{p})}$ where the value of $n_{\mathrm{PUCCH}}^{(3,\tilde{p})}$ 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 Subclause 10.2, if a PDCCH corresponding to a PDSCH on the primary cell within subframe(s) $n-k$, where $k \in K$, or a PDCCH indicating downlink SPS release (defined in Subclause 9.2) within subframe(s) $n-k$, where $k \in K$, 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) $n-k$, where $k \in K$ 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) $n-k$, where $k \in K$. For a UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} as defined in Subclause 10.2, if an EPDCCH corresponding to a PDSCH on the primary cell within subframe(s) $n-k$, where $k \in K$, or an EPDCCH indicating downlink SPS release (defined in Subclause 9.2) within subframe(s) $n-k$, where $k \in K$, 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) $n-k$, where $k \in K$ 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) $n-k$, where $k \in K$.

- For PUCCH format 3 and PUCCH resource $n_{\mathrm{PUCCH}}^{(3,\tilde{p})}$ 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 $n_{\mathrm{PUCCH}}^{(3,\tilde{p}_0)}$ for antenna port p_0 and the second PUCCH resource $n_{\mathrm{PUCCH}}^{(3,\tilde{p}_1)}$ for antenna port p_1, otherwise, the PUCCH resource value maps to a single PUCCH resource $n_{\mathrm{PUCCH}}^{(3,\tilde{p}_0)}$ for antenna port p_0.

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 Subclause 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 Subclause 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 Subclause 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 $K' = K$ where the set K is defined in Table 10.1.3.1-1 (where "UL/DL configuration" in the table refers to the higher layer parameter *subframeAssignment*), and M' is the number of elements in set K'.

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 Subclause K is as defined in Sec 10.2, and M is the number of elements in the set K.

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

For TDD HARQ-ACK transmission with PUCCH format 4 and sub-frame n with $M \geq 1$ and more than one configured serving cell, where M is the number of elements in the set K, the UE shall use PUCCH resource $n_{\text{PUCCH}}^{(4)}$ or $n_{\text{PUCCH}}^{(1,\tilde{p})}$ for transmission of HARQ-ACK and scheduling request (if any) and periodic CSI (if any) in subframe n for $\tilde{p}$ 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 $n-k_m$, where $k_m \in K$, 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$, 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 $n_{\text{PUCCH}}^{(1,\tilde{p})}$ with $n_{\text{PUCCH}}^{(1,\tilde{p}_0)} = (M-m-1)\cdot N_c + m\cdot N_{c+1} + n_{\text{CCE},m} + N_{\text{PUCCH}}^{(1)}$ for antenna port p_0, where $N_{\text{PUCCH}}^{(1)}$ is configured by higher layers, c is selected from {0, 1, 2, 3} such that $N_c \leq n_{\text{CCE},m} < N_{c+1}$, $N_c = \max\left\{0, \left\lfloor [N_{\text{RB}}^{\text{DL}} \cdot (N_{\text{sc}}^{\text{RB}} \cdot c - 4)]/36 \right\rfloor\right\}$, and $n_{\text{CCE,m}}$ is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n-k_m$ where $k_m \in K$. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port p_1 is given by $n_{\text{PUCCH}}^{(1,\tilde{p}_1)} = n_{\text{PUCCH}}^{(1,\tilde{p}_0)} + 1$
- 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 $n-k_m$, where $k_m \in K$, 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$, 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 k_m is same as the value of an element k'_{i2}, where $k'_{i2} \in K'$, the PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p})}$ is given by $n_{\text{PUCCH}}^{(1,\tilde{p})} = (M'-i2-1)\cdot N_c + i2\cdot N_{c+1} + n_{\text{CCE},m} + N_{\text{PUCCH}}^{(1)}$;

- otherwise, if the value of k_m is same as the value of an element k_{i3}^A in set K^A, where $k_{i3}^A \in K^A$ (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 $n_{\text{PUCCH}}^{(1,\tilde{p})}$ is given by

  $n_{\text{PUCCH}}^{(1,\tilde{p})} = (M^A - i3 - 1) \cdot N_c + i3 \cdot N_{c+1} + n_{\text{CCE},m} + N_{\text{PUCCH}}^{\text{K}^A}$;

  where M^A is the number of elements in the set K^A defined in Table 10.1.3.1-1A , where c is selected from {0, 1, 2, 3} such that $N_c \le n_{\text{CCE},m} < N_{c+1}$,

  $N_c = \max\left\{0, \left\lfloor [N_{\text{RB}}^{\text{DL}} \cdot (N_{\text{sc}}^{\text{RB}} \cdot c - 4)]/36 \right\rfloor\right\}$ where $N_{\text{RB}}^{\text{DL}}$ is determined from the primary cell, $n_{CCE,m}$ is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n - k_m$, and $N_{\text{PUCCH}}^{\text{K}^A}$, $N_{\text{PUCCH}}^{(1)}$, are configured by higher layers. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port p_1 is given by $n_{\text{PUCCH}}^{(1,\tilde{p}_1)} = n_{\text{PUCCH}}^{(1,\tilde{p}_0)} + 1$

- 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 $n - k_m$, where $k_m \in K$, 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 Subclause 9.2) in subframe $n - k_m$, where $k_m \in K$, 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 $n_{\text{PUCCH}}^{(1,\tilde{p})}$ given by
      - If EPDCCH-PRB-set q is configured for distributed transmission

        $$n_{\text{PUCCH}}^{(1,\tilde{p})} = n_{\text{ECCE,q}} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + \Delta_{ARO} + N_{\text{PUCCH,q}}^{(\text{e1})}$$

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

        $$n_{\text{PUCCH}}^{(1,\tilde{p})} = \left\lfloor \frac{n_{\text{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + n' + \Delta_{ARO} + N_{\text{PUCCH,q}}^{(\text{e1})}$$

        where $n_{\text{ECCE,q}}$ 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 q in subframe $n - k_m$, $N_{\text{PUCCH,q}}^{(\text{e1})}$ for EPDCCH-PRB-set q is configured by the higher layer parameter pucch-ResourceStartOffset-r11 , $N_{RB}^{ECCE,q}$ for EPDCCH-PRB-set q in subframe $n - k_m$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n - k_m$ which is described in Subclause 6.8A.5 in [3]. If $m = 0$, Δ_{ARO} 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 $m > 0$, Δ_{ARO} 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 $n - k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs in EPDCCH-PRB-set q configured for that UE in subframe $n - k_{i1}$. If the UE is not configured to monitor EPDCCH in subframe $n - k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs computed

assuming EPDCCH-PRB-set q is configured for that UE in subframe $n-k_{i1}$. For normal downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 5, $N_{ECCE,q,n-k_{i1}}$ is equal to 0. For extended downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 4 or 7, $N_{ECCE,q,n-k_{i1}}$ is equal to 0. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port p_1 is given by $n_{\text{PUCCH}}^{(1,\tilde{p}_1)} = n_{\text{PUCCH}}^{(1,\tilde{p}_0)} + 1$.

- 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 $n-k_m$, where $k_m \in K$, 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$, 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 $n_{\text{PUCCH}}^{(1,\tilde{p})}$ given by
      - if EPDCCH-PRB-set q is configured for distributed transmission

$$n_{\text{PUCCH}}^{(1,\tilde{p})} = n_{\text{ECCE,q}} + \sum_{i1=0}^{i4-1} N'_{ECCE,q,n-k'_{i1}} + \sum_{i1=0}^{i5-1} N'_{ECCE,q,n-k_{i1}^{A}} + \Delta'_{ARO} + N_{\text{PUCCH,q}}^{(\text{e1})}$$

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

$$n_{\text{PUCCH}}^{(1,\tilde{p})} = \left\lfloor \frac{n_{\text{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + \sum_{i1=0}^{i4-1} N'_{ECCE,q,n-k'_{i1}} + \sum_{i1=0}^{i5-1} N'_{ECCE,q,n-k_{i1}^{A}} + n' + \Delta'_{ARO} + N_{\text{PUCCH,q}}^{(\text{e1})}$$

        where
        - if the value of k_m is same as the value of an index k'_{i2}, where $k'_{i2} \in K'$, then $i4 = i2$;
        - otherwise, if the value of k_m is same as the value of an index k_{i3}^{A}, where $k_{i3}^{A} \in K^{A}$, then $i4 = i3$;

        and where $n_{\text{ECCE,q}}$ 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 q in subframe $n-k_m$, $N_{\text{PUCCH,q}}^{(\text{e1})}$ for EPDCCH-PRB-set q is configured by the higher layer parameter *pucch-ResourceStartOffset-r11* , $N_{RB}^{ECCE,q}$ for EPDCCH-PRB-set q in subframe $n-k_m$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n-k_m$ which is described in Subclause 6.8A.5 in [3]. Δ'_{ARO}, $N'_{ECCE,q,n-k'_{i1}}$, $N'_{ECCE,q,n-k_{i1}^{A}}$ are determined as described in Subclause 10.1.3.1. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port p_1 is given by $n_{\text{PUCCH}}^{(1,\tilde{p}_1)} = n_{\text{PUCCH}}^{(1,\tilde{p}_0)} + 1$.

- for a single PDSCH transmission only on the primary cell where there is not a corresponding PDCCH/EPDCCH detected within subframe(s) $n-k$, where $k \in K$ and no PDCCH/EPDCCH indicating downlink SPS release (defined in Subclause 9.2) within subframe(s) $n-k$, where $k \in K$, the UE shall use PUCCH format 1a/1b and PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p})}$ with the value of $n_{\text{PUCCH}}^{(1,\tilde{p})}$ 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 $n_{\text{PUCCH}}^{(1,\tilde{p}_0)}$ for antenna port p_0 and the second PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p}_1)}$ for antenna port p_1, otherwise, the PUCCH resource value maps to a single PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p}_0)}$ for antenna port p_0.

- for $M > 1$, and
  - for a PDSCH transmission only on the primary cell where there is not a corresponding PDCCH detected within subframe(s) $n-k$, where $k \in K$, and
    - for an additional PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe $n-k_m$, where $k_m \in K$ 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$ with the DAI value in the PDCCH equal to '1',
      - the UE shall transmit $b(0), b(1)$ in subframe n using PUCCH format 1b on PUCCH resource $n_{\text{PUCCH}}^{(1)}$ selected from A PUCCH resources $n_{\text{PUCCH},i}^{(1)}$ where $0 \le i \le A-1$, according to Table 10.1.3.2-1 and Table 10.1.3.2-2 for $A=2$ and $A=3$, respectively. For a UE configured with a transmission mode that supports up to two transport blocks on the primary cell, $A=3$; otherwise, $A=2$.
        - If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource $n_{\text{PUCCH},0}^{(1)}$ is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource $n_{\text{PUCCH},1}^{(1)}$ is determined as $n_{\text{PUCCH},1}^{(1)} = (M-m-1)\cdot N_c + m\cdot N_{c+1} + n_{\text{CCE},m} + N_{\text{PUCCH}}^{(1)}$, where $N_{\text{PUCCH}}^{(1)}$ is configured by higher layers, c is selected from {0, 1, 2, 3} such that $N_c \le n_{\text{CCE},m} < N_{c+1}$, $N_c = \max\left\{0, \left\lfloor [N_{\text{RB}}^{\text{DL}} \cdot (N_{\text{sc}}^{\text{RB}} \cdot c - 4)]/36 \right\rfloor\right\}$, and $n_{\text{CCE,m}}$ is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n-k_m$ where $k_m \in K$.
        - If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource $n_{\text{PUCCH},0}^{(1)}$ is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource $n_{\text{PUCCH},1}^{(1)}$ is determined as
          - if the value of k_m is same as the value of an element k'_{i2}, where $k'_{i2} \in K'$, the PUCCH resource $n_{\text{PUCCH},1}^{(1)}$ is given by $n_{\text{PUCCH},1}^{(1)} = (M'-i2-1)\cdot N_c + i2\cdot N_{c+1} + n_{\text{CCE},m} + N_{\text{PUCCH}}^{(1)}$;
          - otherwise, if the value of k_m is same as the value of an element k_{i3}^{A} in set K^A, where $k_{i3}^{A} \in K^A$ (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 $n_{\text{PUCCH},1}^{(1)}$ is given by $n_{\text{PUCCH},1}^{(1)} = (M^A-i3-1)\cdot N_c + i3\cdot N_{c+1} + n_{\text{CCE},m} + N_{\text{PUCCH}}^{\text{K}^{\text{A}}}$;

            where M^A is the number of elements in the set K^A defined in Table 10.1.3.1-1A , where c is selected from {0, 1, 2, 3} such that $N_c \le n_{\text{CCE},m} < N_{c+1}$, $N_c = \max\left\{0, \left\lfloor [N_{\text{RB}}^{\text{DL}} \cdot (N_{\text{sc}}^{\text{RB}} \cdot c - 4)]/36 \right\rfloor\right\}$, $n_{CCE,m}$ is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n-k_m$, and $N_{\text{PUCCH}}^{\text{K}^{\text{A}}}$, $N_{\text{PUCCH}}^{(1)}$, 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 $n^{(1)}_{\text{PUCCH},2}$ is determined as $n^{(1)}_{\text{PUCCH},2} = n^{(1)}_{\text{PUCCH},1} + 1$.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 $M > 1$, and
  - for a PDSCH transmission only on the primary cell where there is not a corresponding EPDCCH detected within subframe(s) $n-k$, where $k \in K$, and
    - for an additional PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe $n-k_m$, where $k_m \in K$ 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$ with the DAI value in the EPDCCH equal to '1',
      - the UE shall transmit $b(0), b(1)$ in subframe n using PUCCH format 1b on PUCCH resource $n^{(1)}_{\text{PUCCH}}$ selected from A PUCCH resources $n^{(1)}_{\text{PUCCH},i}$ where $0 \le i \le A-1$, according to Table 10.1.3.2-1 and Table 10.1.3.2-2 for $A=2$ and $A=3$, respectively. For a UE configured with a transmission mode that supports up to two transport blocks on the primary cell, $A=3$; otherwise, $A=2$.
        - If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource $n^{(1)}_{\text{PUCCH},0}$ is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource $n^{(1)}_{\text{PUCCH},1}$ is determined as
          - If EPDCCH-PRB-set q is configured for distributed transmission

$$n^{(1)}_{\text{PUCCH},1} = n_{\text{ECCE,q}} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + \Delta_{ARO} + N^{(\text{e1})}_{\text{PUCCH,q}}$$

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

$$n^{(1)}_{\text{PUCCH},1} = \left\lfloor \frac{n_{\text{ECCE,q}}}{N^{ECCE,q}_{RB}} \right\rfloor \cdot N^{ECCE,q}_{RB} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + n' + \Delta_{ARO} + N^{(\text{e1})}_{\text{PUCCH,q}}$$

            where $n_{\text{ECCE,q}}$ 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 q in subframe $n-k_m$, $N^{(\text{e1})}_{\text{PUCCH,q}}$ for EPDCCH-PRB-set q is configured by the higher layer parameter pucch-ResourceStartOffset-r11 , $N^{ECCE,q}_{RB}$ for EPDCCH-PRB-set q in subframe $n-k_m$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n-k_m$ which is described in Subclause 6.8A.5 in [3]. If $m=0$, Δ_{ARO} 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 $m>0$, Δ_{ARO} 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 $n-k_{i1}$,

$N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs in EPDCCH-PRB-set q configured for that UE in subframe $n-k_{i1}$. If the UE is not configured to monitor EPDCCH in subframe $n-k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs computed assuming EPDCCH-PRB-set q is configured for that UE in subframe $n-k_{i1}$. For normal downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 5, $N_{ECCE,q,n-k_{i1}}$ is equal to 0. For extended downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 4 or 7, $N_{ECCE,q,n-k_{i1}}$ is equal to 0.

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource $n^{(1)}_{\text{PUCCH},0}$ is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource $n^{(1)}_{\text{PUCCH},1}$ is determined as

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

$$n^{(1)}_{\text{PUCCH,i}} = n_{\text{ECCE,q}} + \sum_{i1=0}^{i4-1} N'_{ECCE,q,n-k'_{i1}} + \sum_{i1=0}^{i5-1} N'_{ECCE,q,n-k^{A}_{i1}} + \Delta'_{ARO} + N^{(\text{e1})}_{\text{PUCCH,q}}$$

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

$$n^{(1)}_{\text{PUCCH,i}} = \left\lfloor \frac{n_{\text{ECCE,q}}}{N^{ECCE,q}_{RB}} \right\rfloor \cdot N^{ECCE,q}_{RB} + \sum_{i1=0}^{i4-1} N'_{ECCE,q,n-k'_{i1}} + \sum_{i1=0}^{i5-1} N'_{ECCE,q,n-k^{A}_{i1}} + n' + \Delta'_{ARO} + N^{(\text{e1})}_{\text{PUCCH,q}}$$

    where

    - if the value of k_m is same as the value of an index k'_{i2}, where $k'_{i2} \in K'$, then $i4 = i2$;
    - otherwise, if the value of k_m is same as the value of an index k^{A}_{i3}, where $k^{A}_{i3} \in K^{A}$, then $i4 = i3$;

  - and where $n_{\text{ECCE,q}}$ 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 q in subframe $n-k_m$, $N^{(\text{e1})}_{\text{PUCCH,q}}$ for EPDCCH-PRB-set q is configured by the higher layer parameter *pucch-ResourceStartOffset-r11*, $N^{ECCE,q}_{RB}$ for EPDCCH-PRB-set q in subframe $n-k_m$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n-k_m$ which is described in Subclause 6.8A.5 in [3]. Δ'_{ARO}, $N'_{ECCE,q,n-k'_{i1}}$, $N'_{ECCE,q,n-k^{A}_{i1}}$ are determined as described in Subclause 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 $n^{(1)}_{\text{PUCCH},2}$ is determined as $n^{(1)}_{\text{PUCCH},2} = n^{(1)}_{\text{PUCCH},1} + 1$.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 $M > 1$, and

- for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe $n-k_m$, where $k_m \in K$ 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$ with the DAI value in the PDCCH greater than '1', or
- for $M=9$ and for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe $n-k_m$, where $k_m \in K$ 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) $n-k$, where $k \in K$ with the DAI value equal to '1', or
- for $M=9$ and for a PDCCH indicating downlink SPS release (defined in Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$ 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) $n-k$, where $k \in K$ with the DAI value equal to '1',
  - if the total number of HARQ-ACK bits O^{ACK} and scheduling request bit O^{SR} (if any) and periodic CSI bits $O_{\text{P-CSI}}$ (if any) is more than 22, the UE shall use PUCCH format 4 and PUCCH resource $n_{\text{PUCCH}}^{(4)}$ where the value of $n_{\text{PUCCH}}^{(4)}$ 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) $n-k$, where $k \in K$ 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) $n-k$, where $k \in K$.
  - if the total number of HARQ-ACK bits O^{ACK} and scheduling request bit O^{SR} (if any) and periodic CSI bits $O_{\text{P-CSI}}$ (if any) is no more than 22, the UE shall use PUCCH format 3 and PUCCH resource $n_{\text{PUCCH}}^{(3,\tilde{p})}$ where the value of $n_{\text{PUCCH}}^{(3,\tilde{p})}$ 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) $n-k$, where $k \in K$ 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) $n-k$, where $k \in K$.

- for $M>1$, and
  - for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe $n-k_m$, where $k_m \in K$ 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$ with the DAI value in the EPDCCH greater than '1', or
  - for $M=9$ and for a PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe $n-k_m$, where $k_m \in K$ 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) $n-k$, where $k \in K$ with the DAI value equal to '1', or
  - for $M=9$ and for an EPDCCH indicating downlink SPS release (defined in Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$ 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) $n-k$, where $k \in K$ with the DAI value equal to '1',

- if the total number of HARQ-ACK bits O^{ACK} and scheduling request bit O^{SR} (if any) and periodic CSI bits $O_{\text{P-CSI}}$ (if any) is more than 22, the UE shall use PUCCH format 4 and PUCCH resource $n_{\text{PUCCH}}^{(4)}$ where the value of $n_{\text{PUCCH}}^{(4)}$ 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) $n-k$, where $k \in K$ 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) $n-k$, where $k \in K$.

- if the total number of HARQ-ACK bits O^{ACK} and scheduling request bit O^{SR} (if any) and periodic CSI bits $O_{\text{P-CSI}}$ (if any) is no more than 22, the UE shall use PUCCH format 3 and PUCCH resource $n_{\text{PUCCH}}^{(3,\tilde{p})}$ where the value of $n_{\text{PUCCH}}^{(3,\tilde{p})}$ 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) $n-k$, where $k \in K$ 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) $n-k$, where $k \in K$.

- If the UL/DL configurations of all serving cells are the same and the total number of HARQ-ACK bits O^{ACK} and scheduling request bit O^{SR} (if any) and periodic CSI bits $O_{\text{P-CSI}}$ (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) $n-k$, where $k \in K$, the UE shall use PUCCH format 4 and PUCCH resource $n_{\text{PUCCH}}^{(4)}$ where the value of $n_{\text{PUCCH}}^{(4)}$ 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) $n-k$, where $k \in K$, or a PDCCH indicating downlink SPS release (defined in Subclause 9.2) within subframe(s) $n-k$, where $k \in K$, 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) $n-k$, where $k \in K$ 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) $n-k$, where $k \in K$. For TDD UL/DL configurations 1-6, if an EPDCCH corresponding to a PDSCH on the primary cell within subframe(s) $n-k$, where $k \in K$, or an EPDCCH indicating downlink SPS release (defined in Subclause 9.2) within subframe(s) $n-k$, where $k \in K$, 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) $n-k$, where $k \in K$ 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) $n-k$, where $k \in K$.

- If the UL/DL configurations of at least two serving cells are different and the total number of HARQ-ACK bits O^{ACK} and scheduling request bit O^{SR} (if any) and periodic CSI bits $O_{\text{P-CSI}}$ (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) $n-k$, where $k \in K$, the UE shall use PUCCH format 4 and PUCCH resource $n_{\text{PUCCH}}^{(4)}$ where the value of $n_{\text{PUCCH}}^{(4)}$ 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 Subclause 10.2, if a PDCCH corresponding to a PDSCH on the primary cell within subframe(s) $n-k$, where $k \in K$, or a PDCCH indicating downlink SPS release (defined in Subclause 9.2) within subframe(s) $n-k$, where $k \in K$, 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) $n-k$, where $k \in K$ 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) $n-k$, where $k \in K$. For a UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} as defined in Subclause 10.2, if an EPDCCH corresponding to a PDSCH on the primary cell within subframe(s) $n-k$, where $k \in K$, or an EPDCCH indicating downlink SPS release (defined in Subclause 9.2) within subframe(s) $n-k$, where $k \in K$, 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) $n-k$, where $k \in K$ 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) $n-k$, where $k \in K$.

- If the UL/DL configurations of all serving cells are the same, and the total number of HARQ-ACK bits O^{ACK} and scheduling request bit O^{SR} (if any) and periodic CSI bits $O_{\text{P-CSI}}$ (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) $n-k$, where $k \in K$, the UE shall use PUCCH format 3 and PUCCH resource $n_{\text{PUCCH}}^{(3,\tilde{p})}$ where the value of $n_{\text{PUCCH}}^{(3,\tilde{p})}$ 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) $n-k$, where $k \in K$, or a PDCCH indicating downlink SPS release (defined in subclause 9.2) within subframe(s) $n-k$, where $k \in K$, 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) $n-k$, where $k \in K$ 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) $n-k$, where $k \in K$. For TDD UL/DL configurations 1-6, if an EPDCCH corresponding to a PDSCH on the primary cell within subframe(s) $n-k$, where $k \in K$, or an EPDCCH indicating downlink SPS release (defined in subclause 9.2) within subframe(s) $n-k$, where $k \in K$, 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) $n-k$, where $k \in K$ 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) $n-k$, where $k \in K$. 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 $n_{\text{PUCCH}}^{(3,\tilde{p})}$ for antenna port p_0 and the second PUCCH resource $n_{\text{PUCCH}}^{(3,\tilde{p})}$ for antenna port p_1, otherwise, the PUCCH resource value maps to a single PUCCH resource $n_{\text{PUCCH}}^{(3,\tilde{p})}$ for antenna port p_0.

- If the UL/DL configurations of at least two serving cells are different and the total number of HARQ-ACK bits O^{ACK} and scheduling request bit O^{SR} (if any) and periodic CSI bits $O_{\text{P-CSI}}$ (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) $n-k$, where $k \in K$, the UE shall use PUCCH format 3 and PUCCH resource $n_{\text{PUCCH}}^{(3,\tilde{p})}$

where the value of $n_{\mathrm{PUCCH}}^{(3,\tilde{p})}$ 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 subclause 10.2, if a PDCCH corresponding to a PDSCH on the primary cell within subframe(s) $n-k$, where $k \in K$, or a PDCCH indicating downlink SPS release (defined in subclause 9.2) within subframe(s) $n-k$, where $k \in K$, 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) $n-k$, where $k \in K$ 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) $n-k$, where $k \in K$. For a UL/DL configuration of the primary cell belonging to {1,2,3,4,5,6} as defined in subclause 10.2, if an EPDCCH corresponding to a PDSCH on the primary cell within subframe(s) $n-k$, where $k \in K$, or an EPDCCH indicating downlink SPS release (defined in subclause 9.2) within subframe(s) $n-k$, where $k \in K$, 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) $n-k$, where $k \in K$ 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) $n-k$, where $k \in K$. 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 $n_{\mathrm{PUCCH}}^{(3,\tilde{p})}$ for antenna port p_0 and the second PUCCH resource $n_{\mathrm{PUCCH}}^{(3,\tilde{p})}$ for antenna port p_1, otherwise, the PUCCH resource value maps to a single PUCCH resource $n_{\mathrm{PUCCH}}^{(3,\tilde{p})}$ for antenna port p_0.

10.1.3.2.3.2 PUCCH format 4 HARQ-ACK procedure with adaptive codebook

The procedure in this Subclause 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 $K' = K$ where the set K is defined in Table 10.1.3.1-1 (where "UL/DL configuration" in the table refers to the higher layer parameter *subframeAssignment*), and M' is the number of elements in set K'.

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 Subclause K is as defined in Sec 10.2, and M is the number of elements in the set K.

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

For TDD HARQ-ACK transmission with PUCCH format 4 and sub-frame n with $M \geq 1$ and more than one configured serving cell, where M is the number of elements in the set K, the UE shall use PUCCH resource $n_{\mathrm{PUCCH}}^{(4)}$ or $n_{\mathrm{PUCCH}}^{(3,\tilde{p})}$ or $n_{\mathrm{PUCCH}}^{(1,\tilde{p})}$ for transmission of HARQ-ACK and scheduling request (if any) and periodic CSI (if any) in subframe n for $\tilde{p}$ 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 $n-k_m$, where $k_m \in K$, 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$, 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 $n_{\text{PUCCH}}^{(1,\tilde{p})}$ with $n_{\text{PUCCH}}^{(1,\tilde{p}_0)} = (M-m-1)\cdot N_c + m\cdot N_{c+1} + n_{\text{CCE},m} + N_{\text{PUCCH}}^{(1)}$ for antenna port p_0, where $N_{\text{PUCCH}}^{(1)}$ is configured by higher layers, c is selected from {0, 1, 2, 3} such that $N_c \le n_{\text{CCE},m} < N_{c+1}$, $N_c = \max\left\{0, \left\lfloor [N_{\text{RB}}^{\text{DL}}\cdot(N_{\text{sc}}^{\text{RB}}\cdot c - 4)]/36 \right\rfloor\right\}$, and $n_{\text{CCE,m}}$ is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n-k_m$ where $k_m \in K$. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port p_1 is given by $n_{\text{PUCCH}}^{(1,\tilde{p}_1)} = n_{\text{PUCCH}}^{(1,\tilde{p}_0)} + 1$

- 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 $n-k_m$, where $k_m \in K$, 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$, 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 k_m is same as the value of an element k'_{i2}, where $k'_{i2} \in K'$, the PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p})}$ is given by $n_{\text{PUCCH}}^{(1,\tilde{p})} = (M'-i2-1)\cdot N_c + i2\cdot N_{c+1} + n_{\text{CCE},m} + N_{\text{PUCCH}}^{(1)}$;
      - otherwise, if the value of k_m is same as the value of an element k_{i3}^A in set K^A, where $k_{i3}^A \in K^A$ (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 $n_{\text{PUCCH}}^{(1,\tilde{p})}$ is given by $n_{\text{PUCCH}}^{(1,\tilde{p})} = (M^A - i3 - 1)\cdot N_c + i3\cdot N_{c+1} + n_{\text{CCE},m} + N_{\text{PUCCH}}^{\text{K}^{\text{A}}}$;

        where M^A is the number of elements in the set K^A defined in Table 10.1.3.1-1A , where c is selected from {0, 1, 2, 3} such that $N_c \le n_{\text{CCE},m} < N_{c+1}$, $N_c = \max\left\{0, \left\lfloor [N_{\text{RB}}^{\text{DL}}\cdot(N_{\text{sc}}^{\text{RB}}\cdot c - 4)]/36 \right\rfloor\right\}$ where $N_{\text{RB}}^{\text{DL}}$ is determined from the primary cell, $n_{CCE,m}$ is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n-k_m$, and $N_{\text{PUCCH}}^{\text{K}^{\text{A}}}$, $N_{\text{PUCCH}}^{(1)}$, are configured by higher layers. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port p_1 is given by $n_{\text{PUCCH}}^{(1,\tilde{p}_1)} = n_{\text{PUCCH}}^{(1,\tilde{p}_0)} + 1$

- 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 $n-k_m$, where $k_m \in K$, 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$, 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 $n_{\text{PUCCH}}^{(1,\tilde{p})}$ given by
      - If EPDCCH-PRB-set q is configured for distributed transmission

$$n_{\mathrm{PUCCH}}^{(1,\tilde{p})} = n_{\mathrm{ECCE,q}} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

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

$$n_{\mathrm{PUCCH}}^{(1,\tilde{p})} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + n' + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

where $n_{\mathrm{ECCE,q}}$ 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 q in subframe $n-k_m$, $N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$ for EPDCCH-PRB-set q is configured by the higher layer parameter pucch-ResourceStartOffset-r11 , $N_{RB}^{ECCE,q}$ for EPDCCH-PRB-set q in subframe $n-k_m$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n-k_m$ which is described in Subclause 6.8A.5 in [3]. If $m=0$, Δ_{ARO} 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 $m>0$, Δ_{ARO} 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 $n-k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs in EPDCCH-PRB-set q configured for that UE in subframe $n-k_{i1}$. If the UE is not configured to monitor EPDCCH in subframe $n-k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs computed assuming EPDCCH-PRB-set q is configured for that UE in subframe $n-k_{i1}$. For normal downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 5, $N_{ECCE,q,n-k_{i1}}$ is equal to 0. For extended downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 4 or 7, $N_{ECCE,q,n-k_{i1}}$ is equal to 0. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port p_1 is given by $n_{\mathrm{PUCCH}}^{(1,\tilde{p}_1)} = n_{\mathrm{PUCCH}}^{(1,\tilde{p}_0)} + 1$.

- 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 $n-k_m$, where $k_m \in K$, 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$, 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 $n_{\mathrm{PUCCH}}^{(1,\tilde{p})}$ given by
      - if EPDCCH-PRB-set q is configured for distributed transmission

$$n_{\mathrm{PUCCH}}^{(1,\tilde{p})} = n_{\mathrm{ECCE,q}} + \sum_{i1=0}^{i4-1} N'_{ECCE,q,n-k'_{i1}} + \sum_{i1=0}^{i5-1} N'_{ECCE,q,n-k_{i1}^{A}} + \Delta'_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

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

$$n_{\mathrm{PUCCH}}^{(1,\tilde{p})} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + \sum_{i1=0}^{i4-1} N'_{ECCE,q,n-k'_{i1}} + \sum_{i1=0}^{i5-1} N'_{ECCE,q,n-k_{i1}^{A}} + n' + \Delta'_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

where

- if the value of k_m is same as the value of an index k'_{i2}, where $k'_{i2} \in K'$, then $i4 = i2$;
- otherwise, if the value of k_m is same as the value of an index k_{i3}^A, where $k_{i3}^A \in K^A$, then $i4 = i3$;

and where $n_{\text{ECCE,q}}$ 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 q in subframe $n-k_m$, $N_{\text{PUCCH,q}}^{(\text{e1})}$ for EPDCCH-PRB-set q is configured by the higher layer parameter *pucch-ResourceStartOffset-r11*, $N_{RB}^{ECCE,q}$ for EPDCCH-PRB-set q in subframe $n-k_m$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n-k_m$ which is described in Subclause 6.8A.5 in [3]. Δ'_{ARO}, $N'_{ECCE,q,n-k'_{i1}}$, $N'_{ECCE,q,n-k_{i1}^A}$ are determined as described in Subclause 10.1.3.1. When two antenna port transmission is configured for PUCCH format 1a/1b, the PUCCH resource for antenna port p_1 is given by $n_{\text{PUCCH}}^{(1,\tilde{p}_1)} = n_{\text{PUCCH}}^{(1,\tilde{p}_0)} + 1$.

- for a single PDSCH transmission only on the primary cell where there is not a corresponding PDCCH/EPDCCH detected within subframe(s) $n-k$, where $k \in K$ and no PDCCH/EPDCCH indicating downlink SPS release (defined in Subclause 9.2) within subframe(s) $n-k$, where $k \in K$, the UE shall use PUCCH format 1a/1b and PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p})}$ with the value of $n_{\text{PUCCH}}^{(1,\tilde{p})}$ 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 $n_{\text{PUCCH}}^{(1,\tilde{p}_0)}$ for antenna port p_0 and the second PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p}_1)}$ for antenna port p_1, otherwise, the PUCCH resource value maps to a single PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p}_0)}$ for antenna port p_0.
- for $M > 1$, and
  - for a PDSCH transmission only on the primary cell where there is not a corresponding PDCCH detected within subframe(s) $n-k$, where $k \in K$, and
    - for an additional PDSCH transmission only on the primary cell indicated by the detection of a corresponding PDCCH in subframe $n-k_m$, where $k_m \in K$ 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$ with both the counter DAI value and the total DAI value in the PDCCH equal to '1',
      - the UE shall transmit $b(0), b(1)$ in subframe n using PUCCH format 1b on PUCCH resource $n_{\text{PUCCH}}^{(1)}$ selected from A PUCCH resources $n_{\text{PUCCH},i}^{(1)}$ where $0 \le i \le A-1$, according to Table 10.1.3.2-1 and Table 10.1.3.2-2 for $A=2$ and $A=3$, respectively. For a UE configured with a transmission mode that supports up to two transport blocks on the primary cell, $A=3$; otherwise, $A=2$.
      - If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource $n_{\text{PUCCH},0}^{(1)}$ is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource $n_{\text{PUCCH},1}^{(1)}$ is determined as $n_{\text{PUCCH},1}^{(1)} = (M-m-1)\cdot N_c + m\cdot N_{c+1} + n_{\text{CCE},m} + N_{\text{PUCCH}}^{(1)}$, where $N_{\text{PUCCH}}^{(1)}$ is configured by higher layers, c is selected from {0, 1, 2, 3} such that $N_c \le n_{\text{CCE},m} < N_{c+1}$, $N_c = \max\left\{0, \left\lfloor [N_{\text{RB}}^{\text{DL}} \cdot (N_{\text{sc}}^{\text{RB}} \cdot c - 4)]/36 \right\rfloor\right\}$, and $n_{\text{CCE,m}}$ is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n-k_m$ where $k_m \in K$.

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource $n^{(1)}_{\text{PUCCH},0}$ is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource $n^{(1)}_{\text{PUCCH},1}$ is determined as

  - if the value of k_m is same as the value of an element k'_{i2}, where $k'_{i2} \in K'$, the PUCCH resource $n^{(1)}_{\text{PUCCH},1}$ is given by $n^{(1)}_{\text{PUCCH},1} = (M'-i2-1)\cdot N_c + i2\cdot N_{c+1} + n_{\text{CCE},m} + N^{(1)}_{\text{PUCCH}}$;

  - otherwise, if the value of k_m is same as the value of an element k^A_{i3} in set K^A, where $k^A_{i3} \in K^A$ (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 $n^{(1)}_{\text{PUCCH},1}$ is given by $n^{(1)}_{\text{PUCCH},1} = (M^A - i3 - 1)\cdot N_c + i3\cdot N_{c+1} + n_{\text{CCE},m} + N^{\text{K}^\text{A}}_{\text{PUCCH}}$;

    where M^A is the number of elements in the set K^A defined in Table 10.1.3.1-1A , where c is selected from {0, 1, 2, 3} such that $N_c \le n_{\text{CCE},m} < N_{c+1}$, $N_c = \max\left\{0, \left\lfloor [N^{\text{DL}}_{\text{RB}}\cdot(N^{\text{RB}}_{\text{sc}}\cdot c - 4)]/36 \right\rfloor\right\}$, $n_{CCE,m}$ is the number of the first CCE used for transmission of the corresponding PDCCH in subframe $n-k_m$, and $N^{\text{K}^\text{A}}_{\text{PUCCH}}$, $N^{(1)}_{\text{PUCCH}}$, 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 $n^{(1)}_{\text{PUCCH},2}$ is determined as $n^{(1)}_{\text{PUCCH},2} = n^{(1)}_{\text{PUCCH},1} + 1$.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 $M > 1$, and

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

    - for an additional PDSCH transmission only on the primary cell indicated by the detection of a corresponding EPDCCH in subframe $n-k_m$, where $k_m \in K$ 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 Subclause 9.2) in subframe $n-k_m$, where $k_m \in K$ with both the counter DAI value and the total DAI value in the EPDCCH equal to '1',

      - the UE shall transmit $b(0), b(1)$ in subframe n using PUCCH format 1b on PUCCH resource $n^{(1)}_{\text{PUCCH}}$ selected from A PUCCH resources $n^{(1)}_{\text{PUCCH},i}$ where $0 \le i \le A-1$, according to Table 10.1.3.2-1 and Table 10.1.3.2-2 for $A=2$ and $A=3$, respectively. For a UE configured with a transmission mode that supports up to two transport blocks on the primary cell, $A=3$; otherwise, $A=2$.

        - If the UE is not configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource $n^{(1)}_{\text{PUCCH},0}$ is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource $n^{(1)}_{\text{PUCCH},1}$ is determined as

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

$$n_{\mathrm{PUCCH},1}^{(1)} = n_{\mathrm{ECCE,q}} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

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

$$n_{\mathrm{PUCCH},1}^{(1)} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + \sum_{i1=0}^{m-1} N_{ECCE,q,n-k_{i1}} + n' + \Delta_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

where $n_{\mathrm{ECCE,q}}$ 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 q in subframe $n-k_m$, $N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$ for EPDCCH-PRB-set q is configured by the higher layer parameter pucch-ResourceStartOffset-r11 , $N_{RB}^{ECCE,q}$ for EPDCCH-PRB-set q in subframe $n-k_m$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n-k_m$ which is described in Subclause 6.8A.5 in [3]. If $m=0$, Δ_{ARO} 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 $m>0$, Δ_{ARO} 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 $n-k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs in EPDCCH-PRB-set q configured for that UE in subframe $n-k_{i1}$. If the UE is not configured to monitor EPDCCH in subframe $n-k_{i1}$, $N_{ECCE,q,n-k_{i1}}$ is equal to the number of ECCEs computed assuming EPDCCH-PRB-set q is configured for that UE in subframe $n-k_{i1}$. For normal downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 5, $N_{ECCE,q,n-k_{i1}}$ is equal to 0. For extended downlink CP, if subframe $n-k_{i1}$ is a special subframe with special subframe configuration 0 or 4 or 7, $N_{ECCE,q,n-k_{i1}}$ is equal to 0.

- If the UE is configured with the higher layer parameter *EIMTA-MainConfigServCell-r12* on the primary cell, the PUCCH resource $n_{\mathrm{PUCCH},0}^{(1)}$ is determined according to higher layer configuration and Table 9.2-2. The PUCCH resource $n_{\mathrm{PUCCH},1}^{(1)}$ is determined as

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

$$n_{\mathrm{PUCCH,i}}^{(1)} = n_{\mathrm{ECCE,q}} + \sum_{i1=0}^{i4-1} N'_{ECCE,q,n-k'_{i1}} + \sum_{i1=0}^{i5-1} N'_{ECCE,q,n-k_{i1}^{A}} + \Delta'_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

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

$$n_{\mathrm{PUCCH,i}}^{(1)} = \left\lfloor \frac{n_{\mathrm{ECCE,q}}}{N_{RB}^{ECCE,q}} \right\rfloor \cdot N_{RB}^{ECCE,q} + \sum_{i1=0}^{i4-1} N'_{ECCE,q,n-k'_{i1}} + \sum_{i1=0}^{i5-1} N'_{ECCE,q,n-k_{i1}^{A}} + n' + \Delta'_{ARO} + N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$$

where

- if the value of k_m is same as the value of an index k'_{i2}, where $k'_{i2} \in K'$, then $i4 = i2$;

- otherwise, if the value of k_m is same as the value of an index k_{i3}^A, where $k_{i3}^A \in K^A$, then $i4 = i3$;

- and where $n_{\mathrm{ECCE,q}}$ 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 q in subframe $n-k_m$, $N_{\mathrm{PUCCH,q}}^{(\mathrm{e1})}$ for EPDCCH-PRB-set q is configured by the higher layer parameter *pucch-ResourceStartOffset-r11*, $N_{RB}^{ECCE,q}$ for EPDCCH-PRB-set q in subframe $n-k_m$ is given in Subclause 6.8A.1 in [3], n' is determined from the antenna port used for EPDCCH transmission in subframe $n-k_m$ which is described in Subclause 6.8A.5 in [3]. Δ'_{ARO}, $N'_{ECCE,q,n-k'_{i1}}$, $N'_{ECCE,q,n-k_{i1}^A}$ are determined as described in Subclause 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 $n_{\mathrm{PUCCH,2}}^{(1)}$ is determined as $n_{\mathrm{PUCCH,2}}^{(1)} = n_{\mathrm{PUCCH,1}}^{(1)} + 1$.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 $n-k_m$, where $k_m \in K$ 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 Subclause 9.2) is detected in subframe $n-k_m$, where $k_m \in K$ 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 $n-k$, where $k \in K$ on a secondary cell,

  - if the total number of HARQ-ACK bits O^{ACK} and scheduling request bit O^{SR} (if any) and periodic CSI bits $O_{\mathrm{P-CSI}}$ (if any) is more than 22, the UE shall use PUCCH format 4 and PUCCCH resource $n_{\mathrm{PUCCH}}^{(4)}$ where the value of $n_{\mathrm{PUCCH}}^{(4)}$ is determined according to higher layer configuration and Table 10.1.2.2.3-1. Denote C as the set of configured serving cells for the UE. Denote $k_{smallest}$ is the smallest value in $\bigcup_{c \in C} K_c$ such that PDCCH/EPDCCH scheduling PDSCH or indicating DL SPS release is detected in subframe $n-k_{smallest}$ on serving cell $\tilde{c}$ and $k_{smallest} \in K_{\tilde{c}}$. The TPC field in a PDCCH/EPDCCH scheduling PDSCH or indicating downlink SPS release in subframe $n-k_{smallest}$ on a serving cell c satisfying $k_{smallest} \in K_c$ 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 $n-k_{smallest}$ on any serving cell c satisfying $k_{smallest} \in K_c$.

  - if the total number of HARQ-ACK bits O^{ACK} and scheduling request bit O^{SR} (if any) and periodic CSI bits $O_{\mathrm{P-CSI}}$ (if any) is no more than 22, the UE shall use PUCCH format 3 and PUCCH resource $n_{\mathrm{PUCCH}}^{(3,\tilde{p})}$ where the value of $n_{\mathrm{PUCCH}}^{(3,\tilde{p})}$ is determined according to higher layer configuration and Table 10.1.2.2.2-1. Denote

C as the set of configured serving cells for the UE. Denote $k_{smallest}$ is the smallest value in $\bigcup_{c \in C} K_c$ such that PDCCH/EPDCCH scheduling PDSCH or indicating DL SPS release is detected in subframe $n - k_{smallest}$ on serving cell $\tilde{c}$ and $k_{smallest} \in K_{\tilde{c}}$. The TPC field in a PDCCH/EPDCCH scheduling PDSCH or indicating downlink SPS release in subframe $n - k_{smallest}$ on a serving cell c satisfying $k_{smallest} \in K_c$ 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 $n - k_{smallest}$ on any serving cell c satisfying $k_{smallest} \in K_c$. 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 $n_{\mathrm{PUCCH}}^{(3,\tilde{p}_0)}$ for antenna port p_0 and the second PUCCH resource $n_{\mathrm{PUCCH}}^{(3,\tilde{p}_1)}$ for antenna port p_1, otherwise, the PUCCH resource value maps to a single PUCCH resource $n_{\mathrm{PUCCH}}^{(3,\tilde{p}_0)}$ for antenna port p_0.

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 Subclause 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 Subclause 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 Subclause 10.1.3.2.3.1, by replacing $n_{\mathrm{PUCCH}}^{(4)}$ with $n_{\mathrm{PUCCH}}^{(5)}$.

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 Subclause 10.1.3.2.3.2, by replacing $n_{\mathrm{PUCCH}}^{(4)}$ with $n_{\mathrm{PUCCH}}^{(5)}$.

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 K is defined in Table 10.1.3A-1, otherwise set K is defined in Table 10.1.3.1-1.

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 Subclause 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 M multiple downlink and special subframes associated with a single UL subframe *n*, where M is as defined in Subclause 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 M multiple downlink and special subframes associated with a single UL subframe *n*, where M as defined in Subclause 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 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,

- 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, O, associated with an UL subframe *n* according to $O = \sum_{c=1}^{N_{cells}^{DL}} O_c^{ACK}$ where N_{cells}^{DL} is the number of configured cells, and O_c^{ACK} is the number of HARQ-bits for the *c*-th serving cell defined in Subclause 7.3.4. If a UE is not configured to monitor PDCCH/EPDCCH 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 N_{cells}^{DL} which result in $O > 21$.

HARQ-ACK transmission on two antenna ports $(p \in [p_0, p_1])$ is supported for PUCCH format 3.

HARQ-ACK transmission on two antenna ports $(p \in [p_0, p_1])$ 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 Subclause 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 Subclause 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 $K: \{k_0, k_1, \cdots k_{M-1}\}$ 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 N_{ANRep}, where N_{ANRep} 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 N_{ANRep} times using PUCCH resource $n_{\text{PUCCH}}^{(1,\tilde{p})}$ 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 Subclauses 10.1.2 and 10.1.3), and repeat the transmission of the corresponding HARQ-ACK response $N_{\text{ANRep}}-1$ times always using PUCCH resource $n_{\text{PUCCH,ANRep}}^{(1,\tilde{p})}$, where $n_{\text{PUCCH,ANRep}}^{(1,\tilde{p})}$ 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 $n_{\text{PUCCH,ANRep}}^{(1,\tilde{p})}$ maps to two PUCCH resources with the first PUCCH resource $n_{\text{PUCCH,ANRep}}^{(1,\tilde{p}_0)}$ for antenna port p_0 and the second PUCCH resource $n_{\text{PUCCH,ANRep}}^{(1,\tilde{p}_1)}$ for antenna port p_1, otherwise, the PUCCH resource value maps to a single PUCCH resource $n_{\text{PUCCH,ANRep}}^{(1,\tilde{p}_0)}$ for antenna port p_0.

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) $n_{\text{PUCCH}}^{(1,\tilde{p})} = n_{\text{PUCCH,SRI}}^{(1,\tilde{p})}$ for $\tilde{p}$ mapped to antenna port *p* as defined in [3], where $n_{\text{PUCCH,SRI}}^{(1,\tilde{p})}$ 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 Subclause 5.2.3.1 of [4]. The SR configuration for SR transmission periodicity $SR_{\text{PERIODICITY}}$ and SR subframe offset $N_{\text{OFFSET,SR}}$ is defined in Table 10.1.5-1 by the parameter *sr-ConfigIndex* I_{SR} given by higher layers.

SR transmission instances are the uplink subframes satisfying $\left(10 \times n_f + \lfloor n_s / 2 \rfloor - N_{\text{OFFSET,SR}}\right) \bmod SR_{\text{PERIODICITY}} = 0$.

For a BL/CE UE, the scheduling request shall be transmitted on the PUCCH resource(s) $n_{\text{PUCCH}}^{(1)} = n_{\text{PUCCH,SRI}}^{(1)}$ mapped to antenna port p_0 as defined in [3], where $n_{\text{PUCCH,SRI}}^{(1)}$ is configured by higher layers. The SR configuration for SR transmission periodicity $SR_{\text{PERIODICITY}}$ and SR subframe offset $N_{\text{OFFSET,SR}}$ is defined in Table 10.1.5-1 by the parameter *sr-ConfigIndex* I_{SR} given by higher layers. The SR transmission instances are $N_{\text{PUCCH,rep}}^{(\text{m})}$ consecutive BL/CE uplink subframes when $N_{\text{PUCCH,rep}}^{(\text{m})}$ >1, or one (BL/CE or non-BL/CE) uplink subframe when $N_{\text{PUCCH,rep}}^{(\text{m})}$ =1, where $N_{\text{PUCCH,rep}}^{(\text{m})}$ is provided by higher layer parameter *NumRepetitionCE-format1*, starting from a subframe satisfying $\left(10 \times n_f + \lfloor n_s / 2 \rfloor - N_{\text{OFFSET,SR}}\right) \bmod SR_{\text{PERIODICITY}} = 0$.

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

SR configuration Index I_{SR}	SR periodicity (ms) $SR_{\text{PERIODICITY}}$	SR subframe offset $N_{\text{OFFSET,SR}}$
0 – 4	5	I_{SR}
5 – 14	10	$I_{SR} - 5$
15 – 34	20	$I_{SR} - 15$
35 – 74	40	$I_{SR} - 35$
75 – 154	80	$I_{SR} - 75$
155 – 156	2	$I_{SR} - 155$
157	1	$I_{SR} - 157$

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 Subclause 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 Subclause 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 n corresponding to a PDSCH transmission in subframes $n-N_{\text{ANRep}}-3, \ldots, n-5$, the UE:

- shall transmit only the HARQ-ACK response (corresponding to the detected PDSCH transmission in subframe $n-4$) on PUCCH in subframes $n, n+1, \ldots, n+N_{\text{ANRep}}-1$;
- shall not transmit any other signal/channel in subframes $n, n+1, \ldots, n+N_{\text{ANRep}}-1$; and
- shall not transmit any HARQ-ACK response repetitions corresponding to any detected PDSCH transmission in subframes $n-3, \ldots, n+N_{\text{ANRep}}-5$.

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) $n-k$, where $k \in K$ and K 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) $n-k$ for serving cell c, where $k \in K_c$ intended for the UE and for which HARQ-ACK response shall be provided, transmit the HARQ-ACK response in UL subframe *n*, wherein set K_c contains values of $k \in K$ such that subframe *n-k* corresponds to a DL subframe or a special subframe for serving cell c, where DL subframe or special subframe of serving cell c 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 c; K 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 c, then the UE shall upon detection of a PDSCH transmission within subframe(s) $n-k$ for serving cell c, where $k \in K_c$ intended for the UE and for which HARQ-ACK response shall be provided, transmit the HARQ-ACK response in UL subframe *n*, wherein set K_c contains values of $k \in K$ such that subframe *n-k* corresponds to a DL subframe or a special subframe for serving cell c, where K 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 c, then the UE shall upon detection of a PDSCH transmission within subframe(s) $n-k$ for serving cell c, where $k \in K_c$ intended for the UE and for which HARQ-ACK response shall be provided, transmit the HARQ-ACK response in UL subframe *n*, wherein set K_c contains values of $k \in K$ such that subframe *n-k* corresponds to a DL subframe or a special subframe for serving cell c, where K 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 c is frame structure type 1 and a UE is not configured to monitor PDCCH/EPDCCH in another serving cell for scheduling the serving cell c, then the UE shall upon detection of a PDSCH transmission within subframe(s) $n-k$ for serving cell c, where

$k \in K_c$, $K_c = K$ and K 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 c is frame structure type 1 and a UE is configured to monitor PDCCH/EPDCCH in another serving cell for scheduling serving cell c, then the UE shall upon detection of a PDSCH transmission within subframe(s) $n-k$ for serving cell c, where $k \in K_c$, $K_c = K$ and K 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 c.

For TDD, if HARQ-ACK repetition is enabled, upon detection of a PDSCH transmission within subframe(s) $n-k$, where $k \in K$ and K 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 n corresponding to a PDSCH transmission in a downlink or special subframe earlier than subframe $n-k$, the UE:

- shall transmit only the HARQ-ACK response (corresponding to the detected PDSCH transmission in subframe $n-k$) on PUCCH in UL subframe n and the next $N_{\text{ANRep}}-1$ UL subframes denoted as $n_1, \ldots, n_{N_{\text{ANRep}}-1}$;
- shall not transmit any other signal/channel in UL subframe n, $n_1, \ldots, n_{N_{\text{ANRep}}-1}$; and
- shall not transmit any HARQ-ACK response repetitions corresponding to any detected PDSCH transmission in subframes $n_i - k$, where $k \in K_i$, K_i is the set defined in Table 10.1.3.1-1 corresponding to UL subframe n_i, and $1 \le i \le N_{\text{ANRep}}-1$.

For TDD, HARQ-ACK bundling, if the UE detects that at least one downlink assignment has been missed as described in Subclause 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 $n_{\text{PUCCH}}^{(1,p_0)}$ derived according to Subclause 10.1.2.1 in subframe(s) $n+k_i$ with $i = 0,1, \ldots, N-1$, where

- subframe $n-4$ is the last subframe in which the PDSCH is transmitted; and
- $0 \le k_0 < k_1 < \ldots, k_{N-1}$ and the value of $N = N_{\text{PUCCH,rep}}^{(\text{m})}$ and $N_{\text{PUCCH,rep}}^{(\text{m})}$ 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) $n+k_i$ with $i = 0,1,\ldots,N-1$ 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

  - $k_0 = 0$

For TDD, a BL/CE UE shall upon detection of a PDSCH within subframe(s) $n-k$, where $k \in K$ and K 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 $n_{\text{PUCCH}}^{(1,p_0)}$ derived according to Subclause 10.1.3.1 in subframe(s) $n+k_i$ with $i = 0,1, \ldots, N-1$, where

- subframe $n-k$ is the last subframe in which the PDSCH is transmitted; and

- $0 \le k_0 < k_1 < \ldots, k_{N-1}$ and the value of $N = N_{\mathrm{PUCCH,rep}}^{(\mathrm{m})}$ and $N_{\mathrm{PUCCH,rep}}^{(\mathrm{m})}$ 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) $n+k_i$ with $i=0,1,\ldots,N-1$ 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

  - $k_0 = 0$

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 first set of PDSCH transmissions being detected before 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 $\Delta f = 1.25$ kHz (Δf defined in [3]) or $\Delta f = 7.5$ kHz in an MBSFN subframe with non-zero-size non-MBSFN region.

A UE is not expected to receive PMCH with Δf other than $\Delta f = 1.25$ kHz or $\Delta f = 7.5$ kHz 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 Subclause 6.5 of [3].

The I_{MCS} for the PMCH is configured by higher layers. If the UE is configured by higher layers to decode the PMCH based on QPSK, 16QAM, 64QAM, and 256QAM then the UE shall use I_{MCS} and Table 7.1.7.1-1A to determine the modulation order (Q_m) and TBS index (I_{TBS}) used in the PMCH. Else the UE shall use I_{MCS} for the PMCH and Table 7.1.7.1-1 to determine the modulation order (Q_m) and TBS index (I_{TBS}) used in the PMCH.
The UE shall then follow the procedure in Subclause 7.1.7.2.1 to determine the transport block size, assuming N_{PRB} is equal to $N_{\text{RB}}^{\text{DL}}$. The UE shall set the redundancy version to 0 for the PMCH.

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 [1]-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 SG.

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 Subclause 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.

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/10 in 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 c , 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 c that would indicate subframe i as a downlink subframe.

For a serving cell c , 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 c that would indicate subframe i as an uplink subframe.

For a serving cell c , 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' l and an 'UL duration' d 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 $i = 0, 1, \ldots, d-1$.

Table 13A-2: UL duration and offset.

Value of 'UL duration and offset' field	UL offset, l (in subframes)	UL duration, d (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