**3GPP TSG RAN WG1 #108-e** **R1-220xxxx**

**e-Meeting, February 21st – March 3rd, 2022**

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| *CR-Form-v12.0* | | | | | | | | |
| **DRAFT CHANGE REQUEST** | | | | | | | | |
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|  | **38.213** | **CR** |  | **rev** |  | **Current version:** | **17.0.0** |  |
|  | | | | | | | | |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

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| ***Title:*** | Corrections on extending NR operation to 71 GHz | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Samsung | | | | | | | | | |
| ***Source to TSG:*** |  | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** |  | | | | |  | ***Date:*** | | | 2022-03-07 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | F |  | | | | | ***Release:*** | | | Rel-17 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) Rel-12 (Release 12)* *Rel-13 (Release 13) Rel-14 (Release 14) Rel-15 (Release 15) Rel-16 (Release 16)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | Corrections on extending of NR operation to 71 GHz. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | 1. Map the HARQ Feedback Timing Indicator to slots for SCS of 480/960 kHz in clause 8.2A. 2. Capture for SCS of 480/960 kHz in clause 9. 3. Capture time domain bundling in clause 9.1.2.1. 4. Capture (a) spatial domain bundling and (b) generation of HARQ-ACK information for PDSCH associated with a TBG and overlapping with an UL symbol in clause 9.1.3.1. 5. Capture configuration aspects for a PDCCH monitoring pattern over a group of slots in clause 10.1. 6. Capture PDCCH MOs for Type0-PDCCH CSS set with SS/PBCH block and CORESET multiplexing pattern 3 for 480/960 kHz in clause 13. 7. Capture search space set group switching timelines for PDCCH monitoring is groups of slots in clause 10.4. 8. Capture the determination of combination of for when more than one such combinations are applicable based on the configuration of search space sets in clause 10. 9. Capture the default combinations for PDCCH monitoring when a UE is not provided *monitoringCapabilityConfig* or prior to RRC connection in clause 10. 10. Capture configurations for CA operation for combinations R17 PDCCH monitoring and R15 and/or R16 PDCCH monitoring on scheduling cells in clause 10. 11. Capture allocations of UE capability for PDCCH monitoring for combinations of scheduling cells with R17 PDCCH monitoring and scheduling cells with R15 and/or R16 PDCCH monitoring in clause 10.1. 12. Determination of when cells with TBG-based HARQ-ACK are included for power determination of a PUCCH that provides UCI with RM encoding in clause 9.3.1. 13. Update Table 4.1-2 in clause 4.1. 14. Capture periodic CSI-RS validation for shared spectrum channel access operation in LBT mode in clause 11.1. 15. Other miscellaneous corrections/alignments. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | Incomplete support for NR extension to 71 GHz. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 4.1, 8.2A, 9.1.2.1, 9.1.3.1, 9.2.1, 10, 10.1, 10.4, 11.1, 13 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | | **X** |  | Other core specifications | | | | TS 38.211, TS 38.212, TS 38.214 | | |
| ***affected:*** | |  | **X** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

\*\*\* Unchanged text is omitted \*\*\*

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in [1, TR 21.905].

BPRE Bits per resource element

BWP Bandwidth part

CB Code block

CBG Code block group

CBR Channel busy ratio

CCE Control channel element

CORESET Control resource set

CP Cyclic prefix

CRC Cyclic redundancy check

C-RNTI Cell RNTI

CS-RNTI Configured scheduling RNTI

CSI Channel state information

CSS Common search space

DAI Downlink assignment index

DAPS Dual active protocol stack

DC Dual connectivity

DCI Downlink control information

DL Downlink

DL-SCH Downlink shared channel

EPRE Energy per resource element

EN-DC E-UTRA NR dual connectivity with MCG using E-UTRA and SCG using NR

FR1 Frequency range 1

FR2 Frequency range 2

G-CS-RNTI Group configured scheduling RNTI

G-RNTI Group RNTI

GSCN Global synchronization channel number

HARQ-ACK Hybrid automatic repeat request acknowledgement

MBS Multicast broadcast services

MCG Master cell group

MCS Modulation and coding scheme

NDI New Data Indicator

NE-DC E-UTRA NR dual connectivity with MCG using NR and SCG using E-UTRA

NR-DC NR NR dual connectivity

PBCH Physical broadcast channel

PCell Primary cell

PDCCH Physical downlink control channel

PDSCH Physical downlink shared channel

PO Paging occasion

PRACH Physical random access channel

PRB Physical resource block

PRG Physical resource block group

PSCell Primary secondary cell

PSBCH Physical sidelink broadcast channel

PSCCH Physical sidelink control channel

PSFCH Physical sidelink feedback channel

PSS Primary synchronization signal

PSSCH Physical sidelink shared channel

PUCCH Physical uplink control channel

PUCCH-SCell PUCCH SCell

PUCCH-sSCell PUCCH switching SCell

PUSCH Physical uplink shared channel

QCL Quasi co-location

RB Resource block

RE Resource element

RLM Radio link monitoring

RRM Radio resource management

RS Reference signal

RSRP Reference signal received power

SCG Secondary cell group

SCI Sidelink control information

SCS Subcarrier spacing

SFCI Sidelink feedback control information

SFN System frame number

SL Sidelink

SLIV Start and length indicator value

SPS Semi-persistent scheduling

SR Scheduling request

SRI SRS resource indicator

SRS Sounding reference signal

SSS Secondary synchronization signal

SSSG Search space set group

TA Timing advance

TAG Timing advance group

TB Transport block

TBG Transport block group

TCI Transmission Configuration Indicator

UCI Uplink control information

UE User equipment

UL Uplink

UL-SCH Uplink shared channel

USS UE-specific search space

# 4 Synchronization procedures

## 4.1 Cell search

\*\*\* Unchanged text is omitted \*\*\*

The candidate SS/PBCH blocks in a half frame are indexed in an ascending order in time from 0 to , where is determined according to SS/PBCH block patterns for Cases A through G. is a maximum number of SS/PBCH block indexes in a cell, and the maximum number of transmitted SS/PBCH blocks within a half frame is .

- For operation without shared spectrum channel access in FR1 and FR2, and for operation with shared spectrum channel access in FR2-2,

- For operation with shared spectrum channel access in FR1, for and 15 kHz SCS of SS/PBCH blocks and for and 30 kHz SCS of SS/PBCH blocks

For , a UE determines the 2 LSB bits of a candidate SS/PBCH block index per half frame from a one-to-one mapping with an index of the DM-RS sequence transmitted in the PBCH as described in [4, TS 38.211].

For , a UE determines the 3 LSB bits of a candidate SS/PBCH block index per half frame from a one-to-one mapping with an index of the DM-RS sequence transmitted in the PBCH as described in [4, TS 38.211]

- for , the UE determines the 1 MSB bit of the candidate SS/PBCH block index from PBCH payload bit as described in [5, TS 38.212]

- for , the UE determines the 2 MSB bits of the candidate SS/PBCH block index from PBCH payload bits as described in [5, TS 38.212]

- for , the UE determines the 3 MSB bits of the candidate SS/PBCH block index from PBCH payload bits as described in [5, TS 38.212]

A UE can be provided per serving cell by *ssb-periodicityServingCell* a periodicity of the half frames for reception of the SS/PBCH blocks for the serving cell. If the UE is not configured a periodicity of the half frames for receptions of the SS/PBCH blocks, the UE assumes a periodicity of a half frame. A UE assumes that the periodicity is same for all SS/PBCH blocks in the serving cell.

For initial cell selection, a UE may assume that half frames with SS/PBCH blocks occur with a periodicity of 2 frames.

For operation without shared spectrum channel access, an SS/PBCH block index is same as a candidate SS/PBCH block index.

For operation with shared spectrum channel access, a UE assumes that transmission of SS/PBCH blocks in a half frame is within a discovery burst transmission window that starts from the first symbol of the first slot in a half-frame. The UE can be provided per serving cell by *discoveryBurstWindowLength* a duration of the discovery burst transmission window. If *discoveryBurstWindowLength* is not provided, the UE assumes that the duration of the discovery burst transmission window is a half frame. For a serving cell, the UE assumes that a periodicity of the discovery burst transmission window is same as a periodicity of half frames for receptions of SS/PBCH blocks in the serving cell. The UE assumes that one or more SS/PBCH blocks indicated by *ssb-PositionsInBurst* may be transmitted within the discovery burst transmission window and have candidate SS/PBCH blocks indexes corresponding to SS/PBCH block indexes provided by *ssb-PositionsInBurst*. If MSB , , of *ssb-PositionsInBurst* is set to 1, the UE assumes that SS/PBCH block(s) within the discovery burst transmission window with candidate SS/PBCH block index(es) corresponding to SS/PBCH block index equal to may be transmitted; if MSB is set to 0, the UE assumes that the SS/PBCH block(s) are not transmitted. If MSB , , of *inOneGroup* is set to 1, and MSB , , of *groupPresence* is set to 1, the UE assumes that SS/PBCH block(s) within the discovery burst transmission window with candidate SS/PBCH block index(es) corresponding to SS/PBCH block index determined by and may be transmitted; otherwise, the UE assumes that the SS/PBCH block(s) are not transmitted.

For operation with shared spectrum channel access in FR1, a UE assumes that SS/PBCH blocks in a serving cell that are within a same discovery burst transmission window or across discovery burst transmission windows are quasi co-located with respect to average gain, quasi co-location 'typeA' and 'typeD' properties, when applicable [6, TS 38.214], if a value of is same among the SS/PBCH blocks. is an index of a DM-RS sequence transmitted in a PBCH of a corresponding SS/PBCH block, and is either provided by *ssb-PositionQCL* or, if *ssb-PositionQCL* is not provided,obtained from a *MIB* provided by a SS/PBCH block according to Table 4.1-1 with [4, TS 38.211]. The UE can determine an SS/PBCH block index according to , or according to where is the candidate SS/PBCH block index. The UE assumes that within a discovery burst transmission window, a number of transmitted SS/PBCH blocks on a serving cell is not larger than and a number of transmitted SS/PBCH blocks with a same SS/PBCH block index is not larger than one.

Table 4.1-1: Mapping between the combination of *subCarrierSpacingCommon* and LSB of *ssb-SubcarrierOffset* to for operation with shared spectrum channel access in FR1

|  |  |  |
| --- | --- | --- |
| *subCarrierSpacingCommon* | LSB of *ssb-SubcarrierOffset* |  |
| scs15or60 | 0 | 1 |
| scs15or60 | 1 | 2 |
| scs30or120 | 0 | 4 |
| scs30or120 | 1 | 8 |

For operation with shared spectrum channel access in FR2-2, a UE assumes that SS/PBCH blocks in a serving cell that are within a same discovery burst transmission window or across discovery burst transmission windows are quasi co-located with respect to average gain, quasi co-location 'typeA' and 'typeD' properties, when applicable, if a value of is same among the SS/PBCH blocks, where is the candidate SS/PBCH block index. is either provided by *ssb-PositionQCL* or, if *ssb-PositionQCL* is not provided,obtained from a *MIB* provided by a SS/PBCH block according to Table 4.1-2. The UE can determine an SS/PBCH block index according to . The UE assumes that within a discovery burst transmission window, a number of transmitted SS/PBCH blocks on a serving cell is not larger than and a number of transmitted SS/PBCH blocks with a same SS/PBCH block index is not larger than one.

Table 4.1-2: Mapping between *subCarrierSpacingCommon* to for operation with shared spectrum channel access in FR2-2

|  |  |
| --- | --- |
| *subCarrierSpacingCommon* |  |
| scs15or60 | 32 |
| scs30or120 | 64 |



For operation without shared spectrum channel access in FR2-2, a UE expects a MIB in a SS/PBCH block to provide *subCarrierSpacingCommon* = ‘scs30or120’.

Upon detection of a SS/PBCH block, the UE determines from *MIB* that a CORESET for Type0-PDCCH CSS set, as described in clause 13, is present if [4, TS 38.211] for FR1 or if for FR2. The UE determines from *MIB* that a CORESET for Type0-PDCCH CSS set is not present if for FR1 or if for FR2; the CORESET for Type0-PDCCH CSS set may be provided by *PDCCH-ConfigCommon*.

For a serving cell without transmission of SS/PBCH blocks, a UE acquires time and frequency synchronization with the serving cell based on receptions of SS/PBCH blocks on the PCell, or on the PSCell, or on an SCell if applicable as described in [10, TS 38.133], of the cell group for the serving cell.

\*\*\* Unchanged text is omitted \*\*\*

## 8.2A Random access response - Type-2 random access procedure

In response to a transmission of a PRACH and a PUSCH, or to a transmission of only a PRACH if the PRACH preamble is mapped to a valid PUSCH occasion, a UE attempts to detect a DCI format 1\_0 with CRC scrambled by a corresponding MsgB-RNTI during a window controlled by higher layers [11, TS 38.321]. The window starts at the first symbol of the earliest CORESET the UE is configured to receive PDCCH for Type1-PDCCH CSS set, as defined in clause 10.1, that is at least one symbol, after the last symbol of the PUSCH occasion corresponding to the PRACH transmission, where the symbol duration corresponds to the SCS for Type1-PDCCH CSS set. The window starts after an additional msec where is defined in [4, TS 38.211] and is provided by *K-Mac* or if *K-Mac* is not provided. The length of the window in number of slots, based on the SCS for Type1-PDCCH CSS set, is provided by *msgB-ResponseWindow*.

In response to a transmission of a PRACH, if the PRACH preamble is not mapped to a valid PUSCH occasion, a UE attempts to detect a DCI format 1\_0 with CRC scrambled by a corresponding MsgB-RNTI during a window controlled by higher layers [11, TS 38.321]. The window starts at the first symbol of the earliest CORESET the UE is configured to receive PDCCH for Type1-PDCCH CSS set, as defined in clause 10.1, that is at least one symbol, after the last symbol of the PRACH occasion corresponding to the PRACH transmission, where the symbol duration corresponds to the SCS for Type1-PDCCH CSS set. The length of the window in number of slots, based on the SCS for Type1-PDCCH CSS set, is provided by *msgB-ResponseWindow*.

If the UE detects the DCI format 1\_0, with CRC scrambled by the corresponding MsgB-RNTI and LSBs of a SFN field in the DCI format 1\_0, if applicable, are same as corresponding LSBs of the SFN where the UE transmitted PRACH, and the UE receives a transport block in a corresponding PDSCH within the window, the UE passes the transport block to higher layers. The higher layers indicate to the physical layer

- an uplink grant if the RAR message(s) is for fallbackRAR and a random access preamble identity (RAPID) associated with the PRACH transmission is identified, and the UE procedure continues as described in clauses 8.2, 8.3, and 8.4 when the UE detects a RAR UL grant, or

- transmission of a PUCCH with HARQ-ACK information having ACK value if the RAR message(s) is for successRAR, where

- a PUCCH resource for the transmission of the PUCCH is indicated by PUCCH resource indicator field of 4 bits in the successRAR from a PUCCH resource set that is provided by *pucch-ResourceCommon*

- a slot for the PUCCH transmission is indicated by a HARQ Feedback Timing Indicator field of 3 bits in the successRAR having a value from {1, 2, 3, 4, 5, 6, 7, 8} for , from {7, 8, 12, 16, 20, 24, 28, 32} for , and from {13, 16, 24, 32, 40, 48, 56, 64} for and, with reference to slots for PUCCH transmission having duration , the slot is determined as , where is a slot of the PDSCH reception, is as defined for PUSCH transmission in Table 6.1.2.1.1-5 of [6, TS 38.214], is the SCS configuration of the active UL BWP, and is provided by *Koffset* in *ServingCellConfigCommon*; otherwise, if not provided,

- the UE does not expect the first symbol of the PUCCH transmission to be after the last symbol of the PDSCH reception by a time smaller than msec where is the PDSCH processing time for UE processing capability 1 [6, TS 38.214]

- for operation with shared spectrum channel access, a channel access type and CP extension [15, TS 37.213] for a PUCCH transmission is indicated by a ChannelAccess-CPext field in the successRAR as defined in Table 7.3.1.1.1-4 in TS 38.212 or Table 7.3.1.1.1-4A in TS 38.212 if *ChannelAccessMode-r16* = "*semistatic*" is provided

- the PUCCH transmission is with a same spatial domain transmission filter and in a same active UL BWP as a last PUSCH transmission

If the UE detects the DCI format 1\_0 with CRC scrambled by a C-RNTI and a transport block in a corresponding PDSCH within the window, the UE transmits a PUCCH with HARQ-ACK information having ACK value if the UE correctly detects the transport block or NACK value if the UE incorrectly detects the transport block and the time alignment timer is running [11, TS 38.321].

If the UE detects a DCI format 1\_0 with CRC scrambled by the corresponding MsgB-RNTI and receives a transport block within the window in a corresponding PDSCH, the UE may assume same DM-RS antenna port quasi co-location properties, as described in [6, TS 38.214], as for a SS/PBCH block the UE used for PRACH association, as described in clause 8.1, regardless of whether or not the UE is provided *TCI-State* for the CORESET where the UE receives the PDCCH with the DCI format 1\_0.

The UE does not expect to be indicated to transmit the PUCCH with the HARQ-ACK information at a time that is prior to a time when the UE applies a TA command that is provided by the transport block. If the UE does not detect the DCI format 1\_0 with CRC scrambled by the corresponding MsgB-RNTI within the window, or if the UE detects the DCI format 1\_0 with CRC scrambled by the corresponding MsgB-RNTI within the window and LSBs of a SFN field in the DCI format 1\_0, if applicable, are not same as corresponding LSBs of the SFN where the UE transmitted the PRACH, or if the UE does not correctly receive the transport block in the corresponding PDSCH within the window, or if the higher layers do not identify the RAPID associated with the PRACH transmission from the UE, the higher layers can indicate to the physical layer to transmit only PRACH according to Type-1 random access procedure or to transmit both PRACH and PUSCH according to Type-2 random access procedure [11, TS 38.321]. If requested by higher layers, the UE is expected to transmit a PRACH no later than msec after the last symbol of the window, or the last symbol of the PDSCH reception, where is a time duration of symbols corresponding to a PDSCH processing time for UE processing capability 1 when additional PDSCH DM-RS is configured. For , the UE assumes [6, TS 38.214].

Unless the UE is configured a SCS, the UE receives subsequent PDSCH using same SCS as for the PDSCH reception providing the RAR message.

If the UE does not detect the DCI format 1\_0 with CRC scrambled by the corresponding MsgB-RNTI within the window, or if the UE detects the 1\_0 with CRC scrambled by the corresponding MsgB-RNTI within the window and LSBs of a SFN field in the DCI format 1\_0, if applicable, are not same as corresponding LSBs of the SFN where the UE transmitted the PRACH, or the UE does not correctly receive a corresponding transport block within the window, the UE procedure is as described in [11, TS 38.321].

\*\*\* Unchanged text is omitted \*\*\*

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

For a serving cell , an active DL BWP, and an active UL BWP, as described in clause 12, the UE determines a set of occasions for candidate PDSCH receptions for which the UE can transmit corresponding HARQ-ACK information in a PUCCH in slot . If serving cell is deactivated, the UE uses as the active DL BWP for determining the set of occasions for candidate PDSCH receptions a DL BWP provided by *firstActiveDownlinkBWP-Id*. The determination is based:

a) on a set of slot timing values associated with the active UL BWP

- If the UE is configured to monitor PDCCH for DCI format 1\_0 and is not configured to monitor PDCCH for either DCI format 1\_1 or DCI format 1\_2 for serving cell , is provided by the slot timing values {1, 2, 3, 4, 5, 6, 7, 8} for SCS configuration of PUCCH transmission , {7, 8, 12, 16, 20, 24, 28, 32} for , and {13, 16, 24, 32, 40, 48, 56, 64} for .

- If the UE is configured to monitor PDCCH for DCI format 1\_1 and is not configured to monitor PDCCH for DCI format 1\_2 for serving cell , is provided by *dl-DataToUL-ACK*

- If the UE is configured to monitor PDCCH for DCI format 1\_2 and is not configured to monitor PDCCH for DCI format 1\_1 for serving cell , is provided by *dl-DataToUL-ACK-DCI-1-2*

- If the UE is configured to monitor PDCCH for DCI format 1\_1 and DCI format 1\_2 for serving cell , is provided by the union of *dl-DataToUL-ACK* and *dl-DataToUL-ACK-DCI-1-2*

- If the UE is configured to monitor PDCCH for multicast DCI formats for serving cell

- if the UE is not provided *type1-Codebook-Generation-Mode =* 'mode1', is additionally provided by the union of *dl-DataToUL-ACK-ForDCI Format4\_1*

- if the UE is not provided *dl-DataToUL-ACK-ForDCI Format4\_1*, is provided by the slot timing values {1, 2, 3, 4, 5, 6, 7, 8}

- if the UE is provided *type1-Codebook-Generation-Mode =* 'mode1', the UE

- determines a first set as , where is a set of slot timing values for the multicast DCI formats, a second set as , and a third set as

b) on a set of row indexes of a table that is associated with the active DL BWP and defining respective sets of slot offsets , start and length indicators *SLIV*, and PDSCH mapping types for PDSCH reception as described in [6, TS 38.214], where the row indexes of the table are provided by

- the union of row indexes of time domain resource allocation tables for DCI formats the UE is configured to monitor PDCCH for serving cell if the UE is not configured to monitor PDCCH for multicast DCI formats for serving cell , or is not provided *type1-Codebook-Generation-Mode =* 'mode1', or, if any, for the first set

- the union of row indexes of time domain resource allocation tables for DCI format 1\_0 and/or DCI format 1\_1 and/or DCI format 1\_2 for serving cell for the second set, if any

- the union of row indexes of time domain resource allocation tables for multicast DCI formats the UE is configured to monitor PDCCH for serving cell for the third set, if any

- if the UE is provided *referenceOfSLIVDCI-1-2*, for each row index with slot offset and PDSCH mapping Type B in a set of row indexes of a table for DCI format 1\_2 [6, TS 38.214], for any PDCCH monitoring occasion in any slot where the UE monitors PDCCH for DCI format 1\_2 and with starting symbol , if for normal cyclic prefix and for extended cyclic prefix, add a new row index in the set of row indexes of the table by replacing the starting symbol of the row index by

c) on the ratio between the downlink SCS configuration and the uplink SCS configuration provided by *subcarrierSpacing* in *BWP-Downlink* and *BWP-Uplink* for the active DL BWP and the active UL BWP, respectively

d) if provided, on *tdd-UL-DL-ConfigurationCommon* and *tdd-UL-DL-ConfigurationDedicated* as described in clause 11.1

e) if *ca-SlotOffset* is provided, on and provided by ca-SlotOffsetfor serving cell , or on and provided by ca-SlotOffsetfor the primary cell, as described in [4, TS 38.211].

If a UE

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

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

- is provided *ackNackFeedbackMode* = *joint*

where

- a serving cell is placed in a first set of serving cells if the serving cell includes a first CORESET, and

- a serving cell is placed in a second set of serving cells if the serving cell includes a second CORESET, and

- serving cells are placed in a set according to an ascending order of a serving cell index

the UE generates a Type-1 HARQ-ACK codebook for the set and the set of serving cells separately by setting and in the following pseudo-code. The UE concatenates the HARQ-ACK codebook generated for the set followed by the HARQ-ACK codebook generated for the set to obtain a total number of HARQ-ACK information bits.

If a UE is provided *fdmed-Reception-Multicast* and the UE is configured to monitor PDCCH for detection of unicast DCI formats and to monitor PDCCH for detection of multicast DCI formats

- a serving cell is placed in a first set of serving cells if the UE is configured to monitor PDCCH for DCI formats 1\_0/1\_1/1\_2 for scheduling on serving cell , and

- a serving cell is placed in a second set of serving cells if the UE is configured to monitor PDCCH for detection of DCI format 4\_1/4\_2 for scheduling on serving cell , and

- serving cells are placed in a set according to an ascending order of a serving cell index

the UE generates a Type-1 HARQ-ACK codebook for the set and the set of serving cells separately by setting and in the following pseudo-code. The UE concatenates the HARQ-ACK codebook generated for the set followed by the HARQ-ACK codebook generated for the set to obtain a total number of HARQ-ACK information bits.

If the UE is configured to monitor PDCCH for DCI formats with CRC scrambled by G-RNTI or G-CS-RNTI and is provided *type1-Codebook-Generation-Mode* ='mode1', the UE separately applies the following pseudo-code for each of the first set, the second set, and third set as the set of slot timing values , and for the corresponding sets of row indexes as to obtain first, second, and third Type-1 HARQ-ACK sub-codebooks, and concatenates the first, second, and third, Type-1 HARQ-ACK sub-codebooks to obtain the Type-1 HARQ-ACK codebook.

If *enableTimeDomainHARQ-Bundling* is provided

- set

- set to the set of row indexes that include the last SLIV of each row of set

If the set of rows includes a row with more than one SLIV entry as described in [6, TS 38.214] and *enableTimeDomainHARQ-Bundling* is not provided, the set of rows and the set of slot timing values are updated in this clause according to the following pseudo-code.

set to the set of rows

set to the cardinality of

set – index of row in set

set

set

while

set to the set of entries for row

set to the set of values of entries for row

set

set to the cardinality of

set to the cardinality of

set – index of element in set – index of element in

while

*;*

;

end while

while

;

;

end while

;

end while

;

For the set of slot timing values, the UE determines a set of occasions for candidate PDSCH receptions or SPS PDSCH releases or TCI state update according to the following pseudo-code. A location in the Type-1 HARQ-ACK codebook for HARQ-ACK information corresponding to a single SPS PDSCH release is same as for a corresponding SPS PDSCH reception. A location in the Type-1 HARQ-ACK codebook for HARQ-ACK information corresponding to multiple SPS PDSCH releases by a single DCI format is same as for a corresponding SPS PDSCH reception with the lowest SPS configuration index among the multiple SPS PDSCH releases. If a UE provides HARQ-ACK information corresponding to detection of a DCI format that provides TCI state update without scheduling PDSCH reception, as described in [6, TS 38.214], a location in the Type-1 HARQ-ACK codebook for the HARQ-ACK information is same as when the DCI format schedules a PDSCH reception with CBGs or with transport blocks that are correctly decoded.

Set - index of occasion for candidate PDSCH reception or SPS PDSCH release or TCI state update

Set

Set

Set to the cardinality of set

Set – index of slot timing values , in descending order of the slot timing values, in set for serving cell

If a UE is not provided *ca-SlotOffset* for any serving cell of PDSCH receptions and for the serving cell of corresponding PUCCH transmission with HARQ-ACK information

while

if or *subslotLengthForPUCCH* is provided for the HARQ-ACK codebook

Set – index of a DL slot overlapping with an UL slot

Set to a number of DL slots overlapping with UL slot if *subslotLengthForPUCCH* is provided for the HARQ-ACK codebook; otherwise,

while

if *PDSCH-TimeDomainResourceAllocationListForMultiPDSCH* and *enableTimeDomainHARQ-Bundling* are provided for serving cell

;

;

elseif *PDSCH-TimeDomainResourceAllocationListForMultiPDSCH* is provided and *enableTimeDomainHARQ-Bundling* is not provided for serving cell

;

else

Set to the set of rows

end if

Set to the cardinality of

Set – index of row in set

if slot starts at a same time as or after a slot for an active DL BWP change on serving cell or an active UL BWP change on the PCell and slot is before the slot for the active DL BWP change on serving cell or the active UL BWP change on the PCell, or *subslotLengthForPUCCH* is provided for the HARQ-ACK codebook and slot overlaps with UL slot , , where is a DL slot with a smallest index among DL slots overlapping with UL slot ,

;

else

while

if the UE is not provided *enableTimeDomainHARQ-Bundling* and is provided *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated* and, for each slot from slot to slot , at least one symbol of the PDSCH time resource derived by row is configured as ULwhere is the *k*-th slot timing value in set , where is a DL slot with a smallest index among DL slots overlapping with UL slot , or *subslotLengthForPUCCH* is provided for the HARQ-ACK codebook and the end of the PDSCH time resource for row is not within any UL slot , or if *PDSCH-TimeDomainResourceAllocationListForMultiPDSCH* is provided and HARQ-ACK information for PDSCH time resource derived by row in slot cannot be provided in slot

;

elseif the UE is provided *enableTimeDomainHARQ-Bundling* and *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated* and, for each slot , at least one symbol of each PDSCH time resource derived by row of set is configured as UL, where = 0,1,…,, , and is the cardinality of .

;

;

else

;

end if

end while

if the UE does not indicate a capability to receive more than one unicast PDSCH or multicast PDSCH per slot and ,

;

;

else

Set to the cardinality of

Set to the smallest last OFDM symbol index, as determined by the *SLIV*, among all rows of

while

Set

while

if for start OFDM symbol index for row

; - index of occasion for candidate PDSCH reception, or SPS PDSCH release, or TCI state update associated with row

;

;

else

;

end if

end while

;

Set to the smallest last OFDM symbol index among all rows of ;

end while

end if

;

end if

end while

end if

;

end while

else

while

if or *subslotLengthForPUCCH* is provided for the HARQ-ACK codebook

Set – index of a DL slot overlapping with an UL slot

Set to a number of DL slots overlapping with UL slot if *subslotLengthForPUCCH* is provided for the HARQ-ACK codebook; otherwise,

while

if *PDSCH-TimeDomainResourceAllocationListForMultiPDSCH* and *enableTimeDomainHARQ-Bundling* are provided for serving cell

;

;

elseif *PDSCH-TimeDomainResourceAllocationListForMultiPDSCH* is provided and *enableTimeDomainHARQ-Bundling* is not provided for serving cell

;

else

Set to the set of rows

end if

Set to the cardinality of

Set – index of row in set

if slot starts at a same time as or after a slot for an active DL BWP change on serving cell or an active UL BWP change on the PCell and slot is before the slot for the active DL BWP change on serving cell or the active UL BWP change on the PCell where is a DL slot with a smallest index among DL slots overlapping with UL slot , or *subslotLengthForPUCCH* is provided for the HARQ-ACK codebook and slot overlaps with UL slot , ,

;

else

while

if the UE is not provided *enableTimeDomainHARQ-Bundling* and is provided *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated* and, for each slot from slot to slot , at least one symbol of the PDSCH time resource derived by row is configured as ULwhere is the *k*-th slot timing value in set , where is a DL slot with a smallest index among DL slots overlapping with UL slot , or *subslotLengthForPUCCH* is provided for the HARQ-ACK codebook and the end of the PDSCH time resource for row is not within any UL slot , or if *PDSCH-TimeDomainResourceAllocationListForMultiPDSCH* is provided and HARQ-ACK information for PDSCH time resource derived by row in slot cannot be provided in slot

;

elseif the UE is provided *enableTimeDomainHARQ-Bundling* and *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated* and, for each slot , at least one symbol of each PDSCH time resource derived by row of set is configured as UL, where = 0,1,…,.

;

;

else

;

end if

end while

if the UE does not indicate a capability to receive more than one unicast PDSCH or multicast PDSCH per slot and ,

;

;

else

Set to the cardinality of

Set to the smallest last OFDM symbol index, as determined by the *SLIV*, among all rows of

while

Set

while

if for start OFDM symbol index for row

; - index of occasion for candidate PDSCH reception, or SPS PDSCH release, or TCI state update associated with row

;

;

else

;

end if

end while

;

;

Set to the smallest last OFDM symbol index among all rows of ;

end while

end if

;

end if

end while

end if

;

end while

end if

If the UE indicates a capability to receive more than one PDSCH per slot, for occasions of candidate PDSCH receptions corresponding to rows of associated with a same value of , where , the UE does not expect to receive more than one PDSCH in a same DL slot associated with a same *coresetPoolIndex* value if provided, or if *coresetPoolIndex* is not provided.

If a UE receives a SPS PDSCH, or a SPS PDSCH release, or TCI state update, or a PDSCH that is scheduled by a DCI format that does not support CBG-based PDSCH receptions and if

- the UE is configured with one serving cell, and

- , and

- *PDSCH-CodeBlockGroupTransmission* is provided to the UE

the UE generates HARQ-ACK information only for the transport block in the PDSCH, or only for the SPS PDSCH release, or only for the TCI state update.

If a UE receives a SPS PDSCH, or a SPS PDSCH release, or TCI state update, or a PDSCH that is scheduled by a DCI format that does not support CBG-based PDSCH receptions and if

- the UE is configured with more than one serving cells, or

- , and

- *PDSCH-CodeBlockGroupTransmission* is provided to the UE

the UE repeats times the HARQ-ACK information for the transport block in the PDSCH, or for the SPS PDSCH release, or for the TCI state update.

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

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

If *maxNrofCodeWordsScheduledByDCI* indicates reception of two transport blocks, when the UE receives a PDSCH with one transport block or a SPS PDSCH release or a TCI state update, the HARQ-ACK information is associated with the first transport block and the UE generates a NACK for the second transport block if *harq-ACK-SpatialBundlingPUCCH* is not provided and generates HARQ-ACK information with value of ACK for the second transport block if *harq-ACK-SpatialBundlingPUCCH* is provided.

A UE determines HARQ-ACK information bits, for a total number of HARQ-ACK information bits, of a HARQ-ACK codebook for transmission in a PUCCH according to the following pseudo-code. In the following pseudo-code, if the UE does not receive a transport block or a CBG, due to the UE not detecting a corresponding DCI format, the UE generates a NACK value for the transport block or the CBG. The cardinality of the set defines a total number of occasions for PDSCH reception or SPS PDSCH release or TCI state update for serving cell corresponding to the HARQ-ACK information bits.

Set – serving cell index: lower indexes correspond to lower RRC indexes of corresponding cells including, when applicable, cells in the set and the set

Set - HARQ-ACK information bit index

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

while

Set – index of occasion for candidate PDSCH reception, or SPS PDSCH release, or TCI state update

while

if *enableTimeDomainHARQ-Bundling* is provided for serving cell and a PDSCH associated with occasion is scheduled by a DCI format indicating a TDRA row that includes more than one SLIV entry

if *harq-ACK-SpatialBundlingPUCCH* is not provided and the UE is configured by *maxNrofCodeWordsScheduledByDCI* with reception of two transport blocks for the active DL BWP of serving cell

if the PDSCH is associated with the last SLIV in the TDRA row

= binary AND operation of the HARQ-ACK information bits corresponding to first transport blocks in PDSCH receptions, that do not overlap with an uplink symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*, scheduled by the DCI format on serving cell ;

;

= binary AND operation of the HARQ-ACK information bits corresponding to second transport blocks in PDSCH receptions, that do not overlap with an uplink symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*, scheduled by the DCI format on serving cell ;

else

NACK;

;

NACK;

end if

;

elseif *harq-ACK-SpatialBundlingPUCCH* is provided and the UE is configured by *maxNrofCodeWordsScheduledByDCI* with reception of two transport blocks for the active DL BWP of serving cell

if the PDSCH is associated with the last SLIV in the TDRA row;

= binary AND operation of the HARQ-ACK information bits corresponding to all transport blocks in PDSCHs, that do not overlap with an uplink symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*, scheduled by the DCI format of serving cell

if the UE receives one transport block, the UE assumes ACK for the second transport block;

else

= NACK;

end if

;

else

if the PDSCH is associated with the last SLIV in the TDRA row;

=binary AND operation of the HARQ-ACK information bits corresponding to all transport blocks in PDSCHs, that do not overlap with an uplink symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*, scheduled by the DCI format of serving cell

else

= NACK;

end if

;

end if

else

if *harq-ACK-SpatialBundlingPUCCH* is not provided, *PDSCH-CodeBlockGroupTransmission* is not provided, and the UE is configured by *maxNrofCodeWordsScheduledByDCI* with reception of two transport blocks for the active DL BWP of serving cell ,

= HARQ-ACK information bit corresponding to a first transport block of this cell;

;

= HARQ-ACK information bit corresponding to a second transport block of this cell;

;

elseif *harq-ACK-SpatialBundlingPUCCH* is provided, and the UE is configured by *maxNrofCodeWordsScheduledByDCI* with reception of two transport blocks for the active DL BWP of serving cell ,

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

if the UE receives one transport block, the UE assumes ACK for the second transport block;

;

elseif *PDSCH-CodeBlockGroupTransmission* is provided, and CBGs are indicated by *maxCodeBlockGroupsPerTransportBlock* for serving cell ,

Set - CBG index

while

= HARQ-ACK information bit corresponding to CBG of the first transport block;

if the UE is configured by *maxNrofCodeWordsScheduledByDCI* with reception of two transport blocks for the active DL BWP of serving cell

= HARQ-ACK information bit corresponding to CBG of the second transport block;

end if

;

end while

, where is the value of *maxNrofCodeWordsScheduledByDCI* for the active DL BWP of serving cell ;

else

= HARQ-ACK information bit of serving cell ;

;

end if

end if

;

end while

;

end while

If , the UE determines a number of HARQ-ACK information bits for obtaining a transmission power for a PUCCH, as described in clause 7.2.1, as where

- are all DL cells where the UE is configured to receive unicast or multicast PDSCHs

- is the cardinality for the union of all sets of occasions for unicast or multicast PDSCH receptions or SPS PDSCH releases for serving cell

- is the number of transport blocks that the UE receives in PDSCH reception occasion for serving cell if *harq-ACK-SpatialBundlingPUCCH* and *PDSCH-CodeBlockGroupTransmission* are not provided, or the number of transport blocks that the UE receives in PDSCH reception occasion for serving cell if *PDSCH-CodeBlockGroupTransmission* is provided and the PDSCH reception is scheduled by a DCI format that does not support CBG-based PDSCH receptions, or the number of PDSCH receptions if *harq-ACK-SpatialBundlingPUCCH* is provided or SPS PDSCH release or TCI state update in PDSCH reception occasion for serving cell and the UE reports corresponding HARQ-ACK information in the PUCCH.

- if *enableTimeDomainHARQ-Bundling* is provided for serving cell and for a DCI format indicating a TDRA row that includes more than one SLIV entry on the serving cell , the UE considers as received only a PDSCH associated with the last SLIV

- is the number of CBGs the UE receives in a PDSCH reception occasion for serving cell if *PDSCH-CodeBlockGroupTransmission* is provided and the PDSCH reception is scheduled by a DCI format that supports CBG-based PDSCH receptions and the UE reports corresponding HARQ-ACK information in the PUCCH.

\*\*\* Unchanged text is omitted \*\*\*

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

\*\*\* Unchanged text is omitted \*\*\*

If a UE is not provided either *PDSCH-CodeBlockGroupTransmission* or *PDSCH-TimeDomainResourceAllocationListForMultiPDSCH* for any serving cells, or for PDSCH receptions scheduled by a DCI format that does not support CBG-based PDSCH receptions, or for SPS PDSCH reception, or for a DCI format having associated HARQ-ACK information without scheduling PDSCH reception, and if , the UE determines a number of HARQ-ACK information bits for obtaining a transmission power for a PUCCH, as described in clause 7.2.1, as

where

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

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

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

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

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

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

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

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

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

- if or if

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

- if the UE detects at least one DCI format that includes a total DAI field in a last PDCCH monitoring occasion within the or , for G-RNTI or G-CS-RNTI , PDCCH monitoring occasions where the UE detects at least one DCI format scheduling PDSCH reception, or having associated HARQ-ACK information without scheduling PDSCH reception, for any serving cell , or , respectively, is the value of the total DAI in the at least one DCI format that includes a total DAI field

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

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

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

- .

- or , for G-RNTI or G-CS-RNTI , is

- if *harq-ACK-SpatialBundlingPUCCH* is not provided, the number of transport blocks the UE receives in a PDSCH, or the number of transport block groups in PDSCHs if *numberOfHARQ-BundlingGroups* with is provided, scheduled by a DCI format that the UE detects in PDCCH monitoring occasion for serving cell

- else if *harq-ACK-SpatialBundlingPUCCH* is provided, the number of PDSCHs, or the number of PDSCH groups if *numberOfHARQ-BundlingGroups* with is provided, scheduled by a DCI format that the UE detects in PDCCH monitoring occasion for serving cell

- else, the number of DCI formats that the UE detects and have associated a HARQ-ACK information without scheduling PDSCH reception in PDCCH monitoring occasion for serving cell .

- or , for G-RNTI or G-CS-RNTI , is the number of SPS PDSCH receptions by the UE on serving cell for which the UE transmits corresponding HARQ-ACK information in the same PUCCH as for HARQ-ACK information corresponding to PDSCH receptions within the or PDCCH monitoring occasions, respectively.

If a UE

- is provided *PDSCH-CodeBlockGroupTransmission* for serving cells; and

- is not provided *PDSCH-CodeBlockGroupTransmission*, for serving cells where

the UE determines the according to the previous pseudo-code with the following modifications

- is used for the determination of a first HARQ-ACK sub-codebook for

- SPS PDSCH reception,

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

- TCI state update, and

- TB-based PDSCH receptions on the serving cells and on the serving cells,

- is replaced by for the determination of a second HARQ-ACK sub-codebook corresponding to the serving cells for CBG-based PDSCH receptions, and

- if, for an active DL BWP of a serving cell, the UE is not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with value 0 for one or more first CORESETs and is provided *coresetPoolIndex* with value 1 for one or more second CORESETs, and is provided *ackNackFeedbackMode* = *joint,* the serving cell is counted as two times where the first time corresponds to the first CORESETs and the second time corresponds to the second CORESETs, and

- instead of generating one HARQ-ACK information bit per transport block for a serving cell from the serving cells, the UE generates HARQ-ACK information bits, where is the maximum value of across all serving cells and is the value of *maxNrofCodeWordsScheduledByDCI* for serving cell . If for a serving cell it is , the UE generates NACK for the last HARQ-ACK information bits for serving cell

- the pseudo-code operation when *harq-ACK-SpatialBundlingPUCCH* is provided is not applicable

- The counter DAI value and the total DAI value apply separately for each HARQ-ACK sub-codebook

- The UE generates the HARQ-ACK codebook by appending the second HARQ-ACK sub-codebook to the first HARQ-ACK sub-codebook

If , the UE also determines for obtaining a PUCCH transmission power, as described in clause 7.2.1, with

where

- if , is the value of the counter DAI in the last DCI format scheduling CBG-based PDSCH reception that the UE detects within the PDCCH monitoring occasions

- if , is the value of the total DAI in the last DCI format scheduling CBG-based PDSCH reception for any serving cell that the UE detects within the PDCCH monitoring occasions

- , if the UE does not detect any DCI format scheduling CBG-based PDSCH reception for any serving cell in any of the PDCCH monitoring occasions

- is the total number of DCI formats scheduling CBG-based PDSCH receptions that the UE detects within the PDCCH monitoring occasions for serving cell . if the UE does not detect any DCI format scheduling CBG-based PDSCH reception for serving cell in any of the PDCCH monitoring occasions

- is the number of CBGs the UE receives in a PDSCH scheduled by a DCI format that supports CBG-based PDSCH reception that the UE detects in PDCCH monitoring occasion for serving cell and the UE reports corresponding HARQ-ACK information in the PUCCH

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

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

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

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

- The pseudo-code operation when *PDSCH-CodeBlockGroupTransmission* is provided is not applicable.

- The counter DAI value and the total DAI value apply separately for each HARQ-ACK sub-codebook.

- The UE generates the HARQ-ACK codebook by appending the second HARQ-ACK sub-codebook to the first HARQ-ACK sub-codebook.

If a UE is provided *numberOfHARQ-BundlingGroups* and is not provided *harq-ACK-SpatialBundlingPUCCH* for a serving cell , the UE generates HARQ-ACK information over transport block groups (TBGs) for PDSCH receptions where, for a maximum number of PDSCH receptions scheduled by a DCI format on the serving cell, a maximum number of TBGs is provided by *numberOfHARQ-BundlingGroups*. If the UE detects a DCI format scheduling PDSCH receptions on the serving cell , the UE generates HARQ-ACK information bits for first TBs and, if applicable, generates HARQ-ACK information bits for second TBs in the PDSCH receptions as described in clause 9.1.1 by setting and . For a TBG associated with at least one PDSCH that does not overlap with an UL symbol indicated by *tdd-UL-DL-ConfigurationCommon*,or by *tdd-UL-DL-ConfigurationDedicated* if provided, the UE assumes that TB(s) provided by a PDSCH that overlaps with an UL symbol indicated by *tdd-UL-DL-ConfigurationCommon*,or by *tdd-UL-DL-ConfigurationDedicated* if provided, are correctly received. For a TBG associated only with PDSCHs that overlap with UL symbols indicated by *tdd-UL-DL-ConfigurationCommon*,or by *tdd-UL-DL-ConfigurationDedicated* if provided, the UE generates a NACK value for the TBG.

If a UE is provided *numberOfHARQ-BundlingGroups* and *harq-ACK-SpatialBundlingPUCCH* for a serving cell , the UE generates HARQ-ACK information over PDSCH reception groups for PDSCH receptions scheduled by a DCI format on the serving cell where a maximum number of PDSCH reception groups, , is provided by *numberOfHARQ-BundlingGroups*. If the UE detects a DCI format scheduling PDSCH receptions on the serving cell , the UE generates HARQ-ACK information bits for the PDSCH receptions as described in clause 9.1.1 by setting and . For a PDSCH reception group associated with at least one PDSCH that does not overlap with an UL symbol indicated by *tdd-UL-DL-ConfigurationCommon*,or by *tdd-UL-DL-ConfigurationDedicated* if provided, the assumes that TBs provided by a PDSCH that overlaps with an UL symbol indicated by *tdd-UL-DL-ConfigurationCommon*,or by *tdd-UL-DL-ConfigurationDedicated* if provided, are correctly received. For a PDSCH reception group associated only with PDSCHs that overlap with UL symbols indicated by *tdd-UL-DL-ConfigurationCommon*,or by *tdd-UL-DL-ConfigurationDedicated* if provided, the UE generates a NACK value for the PDSCH reception group.

If a UE

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

- is not provided *PDSCH-TimeDomainResourceAllocationListForMultiPDSCH* or is provided *numberOfHARQ-BundlingGroups* with value , for serving cells where

the UE determines the according to the previous pseudo-code with the following modifications

- is used for the determination of a first HARQ-ACK sub-codebook for

- SPS PDSCH reception,

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

- PDSCH reception scheduled by a DCI format scheduling one PDSCH

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

- is replaced by for the determination of a second HARQ-ACK sub-codebook corresponding to the serving cells for TBG-based HARQ-ACK information, or for TB-based HARQ-ACK information corresponding to multiple PDSCH receptions scheduled by a single DCI format, and

- if, for an active DL BWP of a serving cell, the UE is not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with value 0 for one or more first CORESETs and is provided *coresetPoolIndex* with value 1 for one or more second CORESETs, and is provided *ackNackFeedbackMode* = *joint,* the serving cell is counted as two times where the first time corresponds to the first CORESETs and the second time corresponds to the second CORESETs, and

- instead of generating one HARQ-ACK information bit per transport block for a serving cell from the serving cells, the UE generates HARQ-ACK information bits, where is the maximum value between across all serving cells if the UE is provided *numberOfHARQ-BundlingGroups*, and across all serving cells where the UE is not provided *numberOfHARQ-BundlingGroups*, and is the value of *maxNrofCodeWordsScheduledByDCI* for serving cell if *harq-ACK-SpatialBundlingPUCCH* is not provided; else, . If for a serving cell where the UE is provided *numberOfHARQ-BundlingGroups*, it is , the UE generates NACK for the last HARQ-ACK information bits for serving cell . If for a serving cell where the UE is not provided *numberOfHARQ-BundlingGroups*, it is , the UE generates NACK for the last HARQ-ACK information bits for serving cell .

- The pseudo-code operation when *PDSCH-CodeBlockGroupTransmission* is provided is not applicable.

- The counter DAI value and the total DAI value apply separately for each HARQ-ACK sub-codebook.

- The UE generates the HARQ-ACK codebook by appending the second HARQ-ACK sub-codebook to the first HARQ-ACK sub-codebook.

If and , the UE also determines for obtaining a PUCCH transmission power, as described in clause 7.2.1, with

where

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

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

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

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

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

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

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

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

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

- if *numberOfHARQ-BundlingGroups* is not provided, is the number of transport blocks in PDSCHs not overlapping with an UL symbol indicated by *tdd-UL-DL-ConfigurationCommon*, or by *tdd-UL-DL-ConfigurationDedicated* if provided, that the UE receives in serving cell from the serving cells in PDCCH monitoring occasion and the UE reports corresponding HARQ-ACK information in the PUCCH

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

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

|  |  |  |
| --- | --- | --- |
| DAI MSB, LSB | or | Number of {serving cell, PDCCH monitoring occasion}-pair(s) in which PDSCH transmission(s) associated with PDCCH or PDCCH generating a HARQ-ACK information bit without scheduling a PDSCH reception or providing TCI state update is present, denoted as and |
| 0,0 | 1 |  |
| 0,1 | 2 |  |
| 1,0 | 3 |  |
| 1,1 | 4 |  |

Table 9.1.3-1A: Value of counter DAI for

|  |  |  |
| --- | --- | --- |
| **DAI** |  | Number of {serving cell, PDCCH monitoring occasion}-pair(s) in which PDSCH transmission(s) associated with PDCCH or PDCCH generating a HARQ-ACK information bit without scheduling a PDSCH reception or providing TCI state update is present, denoted as and |
| 0 | 1 |  |
| 1 | 2 |  |

\*\*\* Unchanged text is omitted \*\*\*

### 9.2.1 PUCCH Resource Sets

\*\*\* Unchanged text is omitted \*\*\*

If the *format* indicates *PUCCH-format4*, the PUCCH format configured for a PUCCH resource is PUCCH format 4, where the PUCCH resource also includes a number of symbols for a PUCCH transmission provided by *nrofSymbols*, an orthogonal cover code length by *occ-Length*, an orthogonal cover code index by *occ-Index*, and a first symbol for the PUCCH transmission provided by *startingSymbolIndex*. For PUCCH transmission in FR2-2, the PUCCH resource can also include a number of PRBs provided by *nrofPRBs*; otherwise, *.*

If a UE is provided *subslotLengthForPUCCH* in a *PUCCH-Config*, the first symbol of a PUCCH resource provided by *PUCCH-ResourceSet* or *SPS-PUCCH-AN-List* in *PUCCH-Config* or by *n1PUCCH-AN* in *SPS-Config* for multiplexing HARQ-ACK in a PUCCH transmission is relative to the first symbol of the *subslotLengthForPUCCH* symbols [12, TS 38.331]. For the remaining cases, the first symbol of a PUCCH resource is relative to the first symbol of a slot with  symbols [4, TS 38.211].

\*\*\* Unchanged text is omitted \*\*\*

# 10 UE procedure for receiving control information

If the UE is configured with a SCG, the UE shall apply the procedures described in this clause for both MCG and SCG except for PDCCH monitoring in Type0/0A/2-PDCCH CSS sets where the UE is not required to apply the procedures in this clause for the 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.

A UE monitors a set of PDCCH candidates in one or more CORESETs on the active DL BWP on each activated serving cell configured with PDCCH monitoring according to corresponding search space sets where monitoring implies receiving each PDCCH candidate and decoding according to the monitored DCI formats.

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

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

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

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

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

If a UE is provided *monitoringCapabilityConfig* for an active DL BWP of a serving cell, the UE obtains an indication to monitor PDCCH on the active DL BWP of the serving cell for a maximum number of PDCCH candidates and non-overlapping CCEs

- per slot, as in Tables 10.1-2 and 10.1-3, if *monitoringCapabilityConfig* = *r15monitoringcapability*, or

- per span, as in Tables 10.1-2A and 10.1-3A, if *monitoringCapabilityConfig* = *r16monitoringcapability*, or

- per group of slots according to combination , as in Tables 10.1-2B and 10.1-3B, if *monitoringCapabilityConfig* = *r17monitoringcapability*

If the UE is not provided *monitoringCapabilityConfig* for SCS configuration , the UE monitors PDCCH on the active DL BWP of the serving cell for a maximum number of PDCCH candidates and non-overlapping CCEs per slot.

If the UE is not provided *monitoringCapabilityConfig* for SCS configuration , the UE monitors PDCCH on the active DL BWP of the serving cell for a maximum number of PDCCH candidates and non-overlapping CCEs per group of slots according to combination for and for as in Tables 10.1-2B and 10.1-3B. The UE does not expect to monitor PDCCH with SCS configuration before the UE is provided dedicated higher layer parameters.

A UE can indicate a capability to monitor PDCCH according to one or more of the combinations = (2, 2), (4, 3), and (7, 3) per SCS configuration of and . A span is a number of consecutive symbols in a slot where the UE is configured to monitor PDCCH. Each PDCCH monitoring occasion is within one span. If a UE monitors PDCCH on a cell according to combination , the UE supports PDCCH monitoring occasions in any symbol of a slot with minimum time separation of symbols between the first symbol of two consecutive spans, including across slots. A span starts at a first symbol where a PDCCH monitoring occasion starts and ends at a last symbol where a PDCCH monitoring occasion ends, where the number of symbols of the span is up to .

If a UE indicates a capability to monitor PDCCH according to multiple combinations and a configuration of search space sets to the UE for PDCCH monitoring on a cell results to a separation of every two consecutive PDCCH monitoring spans that is equal to or larger than the value of for more than one of the multiple combinations , the UE monitors PDCCH on the cell according to the combination , from the more than one combinations , that is associated with the largest maximum number of and defined in Table 10.1-2A and Table 10.1-3A. The UE expects to monitor PDCCH according to the same combination in every slot on the active DL BWP of a cell.

For SCS configuration or , a UE can indicate a capability to monitor PDCCH according to one or more combinations , where and are numbers of consecutive slots. Groups of slots are consecutive and non-overlapping and the slots are within the slots. The first group of slots starts from the beginning of a subframe. The start of two consecutive groups of slots is separated by slots.

If a UE monitors PDCCH on a cell according to combination , the UE can monitor PDCCH for Type1-PDCCH CSS set provided by dedicated higher layer signalling, Type3-PDCCH CSS sets, and USS sets in any slot of the slots, and the UE can monitor PDCCH for Type0/0A/2-PDCCH CSS set and Type1-PDCCH CSS set provided in *SIB1* in any slot of the slots. The UE determines the number of monitored PDCCH candidates and the number of non-overlapped CCEs for combination based on all search space sets within the slots, as applicable according to the search space set configurations, and maximum corresponding values are provided in Table 10.1-2B and Table 10.1-3B, respectively.

For , if the UE indicates a capability to monitor PDCCH according to multiple combinations and a configuration of search space sets to the UE for PDCCH monitoring on a serving cell results to a separation of every two consecutive groups of slots that is not smaller than for more than one combinations , of the multiple combinations , the UE monitors PDCCH on the cell according to the combination , from the more than one combinations , that is associated with the largest maximum number of and defined in Table 10.1-2B and Table 10.1-3B.

A UE capability for PDCCH monitoring per slot, or per group of slots according to combination , or per span on an active DL BWP of a serving cell is defined by a maximum number of PDCCH candidates and non-overlapped CCEs the UE can monitor per slot, or per group of slots according to combination , or per span, respectively, on the active DL BWP of the serving cell.

For monitoring of a PDCCH candidate by a UE, if the UE

- has received *ssb-PositionsInBurst* in *SIB1* and has not received *ssb-PositionsInBurst* in *ServingCellConfigCommon* for a serving cell, and

- does not monitor PDCCH candidates in a Type0-PDCCH CSS set, and

- at least one RE for a PDCCH candidate overlaps with at least one RE of a candidate SS/PBCH block corresponding to a SS/PBCH block index provided by *ssb-PositionsInBurst* in *SIB1*,

the UE is not required to monitor the PDCCH candidate.

For monitoring of a PDCCH candidate by a UE, if the UE

- has received *ssb-PositionsInBurst* in *ServingCellConfigCommon* for a serving cell, and

- does not monitor PDCCH candidates in a Type0-PDCCH CSS set, and

- at least one RE for a PDCCH candidate overlaps with at least one RE of a candidate SS/PBCH block corresponding to a SS/PBCH block index provided by *ssb-PositionsInBurst* in *ServingCellConfigCommon*,

the UE is not required to monitor the PDCCH candidate.

For monitoring of a PDCCH candidate by a UE, if the UE

- has received *ssb-PositionsInBurst* in *AdditionalPCIInfo* for a serving cell, and

- at least one RE for a PDCCH candidate overlaps with at least one RE of a candidate SS/PBCH block corresponding to a SS/PBCH block index provided by *ssb-PositionsInBurst* in *AdditionalPCIInfo* with same physical cell identity as the one associated with a RS having same quasi-collocation properties as a CORESET for the PDCCH candidate,

the UE is not required to monitor the PDCCH candidate.

If a UE is not provided TCI-State\_r17, the UE is not required to monitor PDCCH candidates for a Type0/0A/1-PDCCH CSS set when the active TCI state for a corresponding CORESET is not associated with *physCellId* in *ServingCellConfigCommon*.

If a UE monitors the PDCCH candidate for a Type0-PDCCH CSS set on the serving cell according to the procedure described in clause 13, the UE may assume that no SS/PBCH block is transmitted in REs used for monitoring the PDCCH candidate on the serving cell.

If at least one RE of a PDCCH candidate for a UE on the serving cell overlaps with at least one RE of *lte-CRS-ToMatchAround*, or of *LTE-CRS-PatternList*, the UE is not required to monitor the PDCCH candidate.

If a UE is provided *availableRB-SetsPerCell,* the UE is not required to monitor PDCCH candidates that overlap with any RB from RB sets that are indicated as unavailable for receptions by an available RB set indicator field in DCI format 2\_0 as described in clause 11.1.1. If the UE does not obtain the available RB set indicator for a symbol, the UE monitors PDCCH candidates on all RB sets in the symbol.

If a UE can support

- a first set of serving cells where the UE is either not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with a single value for all CORESETs on all DL BWPs of each scheduling cell from the first set of serving cells, and

- a second set of serving cells where the UE is not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with a value 0 for a first CORESET, and with a value 1 for a second CORESET on any DL BWP of each scheduling cell from the second set of serving cells

the UE determines, for the purpose of reporting *pdcch-BlindDetectionCA*, a number of serving cells as where is a value reported by the UE.

If a UE indicates in *UE-NR-Capability* a carrier aggregation capability larger than 4 serving cells and the UE is not provided *monitoringCapabilityConfig* for any downlink cell or if the UE is provided *monitoringCapabilityConfig* = *r15monitoringcapability* for all downlink cells where the UE monitors PDCCH, the UE includes in *UE-NR-Capability* an indication for a maximum number of PDCCH candidates and for a maximum number of non-overlapped CCEs the UE can monitor per slot when the UE is configured for carrier aggregation operation over more than 4 cells. When a UE is not configured for NR-DC operation, the UE determines a capability to monitor a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs per slot that corresponds to downlink cells, where

- is if the UE does not provide *pdcch-BlindDetectionCA* where is the number of configured downlink serving cells

- otherwise, is the value of *pdcch-BlindDetectionCA*

When a UE is configured for NR-DC operation, the UE determines a capability to monitor a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs per slot that corresponds to downlink cells for the MCG where is provided by *pdcch-BlindDetection* for the MCG and determines a capability to monitor a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs per slot that corresponds to downlink cells for the SCG where is provided by *pdcch-BlindDetection* for the SCG. When the UE is configured for carrier aggregation operation over more than 4 cells, or for a cell group when the UE is configured for NR-DC operation, the UE does not expect to monitor per slot a number of PDCCH candidates or a number of non-overlapped CCEs that is larger than the maximum number as derived from the corresponding value of .

When a UE is configured for NR-DC operation with a total of downlink cells on both the MCG and the SCG, the UE expects to be provided *pdcch-BlindDetection* for the MCG and *pdcch-BlindDetection* for the SCG with values that satisfy

- *pdcch-BlindDetection* for the MCG + *pdcch-BlindDetection* for the SCG <= *pdcch-BlindDetectionCA*, if the UE reports *pdcch-BlindDetectionCA*, or

- *pdcch-BlindDetection* for the MCG + *pdcch-BlindDetection* for the SCG <= , if the UE does not report *pdcch-BlindDetectionCA*.

For NR-DC operation, the UE may indicate, through *pdcch-BlindDetectionMCG-UE* and *pdcch-BlindDetectionSCG-UE*, respective maximum values for *pdcch-BlindDetection* for the MCG and *pdcch-BlindDetection* for the SCG.

If the UE reports *pdcch-BlindDetectionCA*,

- the value range of *pdcch-BlindDetectionMCG-UE* or of *pdcch-BlindDetectionSCG-UE* is [1, …, *pdcch-BlindDetectionCA*-1], and

- *pdcch-BlindDetectionMCG-UE* + *pdcch-BlindDetectionSCG-UE* >= *pdcch-BlindDetectionCA*.

Otherwise, if  is a maximum total number of downlink cells that the UE can be configured on both the MCG and the SCG for NR-DC as indicated in *UE-NR-Capability*,

- the value range of *pdcch-BlindDetectionMCG-UE* or of *pdcch-BlindDetectionSCG-UE* is [1, 2, 3], and

- *pdcch-BlindDetectionMCG-UE* + *pdcch-BlindDetectionSCG-UE* >= .

If a UE indicates in *UE-NR-Capability* a carrier aggregation capability larger than two downlink cells, the UE includes in *UE-NR-Capability* an indication for a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs that the UE can monitor per span when the UE is configured for carrier aggregation operation over more than two downlink cells with *monitoringCapabilityConfig* = *r16monitoringcapability*. When a UE is not configured for NR-DC operation and the UE is provided *monitoringCapabilityConfig* = *r16monitoringcapability* for all downlink cells where the UE monitors PDCCH, the UE determines a capability to monitor a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs per span that corresponds to downlink cells, where

- is the number of configured downlink cells if the UE does not provide *pdcch-MonitoringCA*

- otherwise, is the value of *pdcch-MonitoringCA*

When a UE is configured for NR-DC operation and the UE is provided *monitoringCapabilityConfig* = *r16monitoringcapability* for all downlink cells where the UE monitors PDCCH, the UE determines a capability to monitor a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs per span that corresponds to

- downlink cells for the MCG where is provided by *pdcch-BlindDetection2* for the MCG, and

- downlink cells for the SCG where is provided by *pdcch-BlindDetection2* for the SCG

When the UE is configured for carrier aggregation operation over more than 2 cells, or for a cell group when the UE is configured for NR-DC operation, the UE does not expect to monitor per span a number of PDCCH candidates or a number of non-overlapped CCEs that is larger than the maximum number as derived from the corresponding value of .

When a UE is configured for NR-DC operation with a total of downlink cells on both the MCG and the SCG and the UE is provided *monitoringCapabilityConfig* = *r16monitoringcapability* for all downlink cells where the UE monitors PDCCH, the UE expects to be provided *pdcch-BlindDetection2* for the MCG and *pdcch-BlindDetection2* for the SCG with values that satisfy

- *pdcch-BlindDetection2* for the MCG + *pdcch-BlindDetection2* for the SCG <= *pdcch-MonitoringCA*, if the UE reports *pdcch-MonitoringCA*, or

- *pdcch-BlindDetection2* for the MCG + *pdcch-BlindDetection2* for the SCG <= , if the UE does not report *pdcch-MonitoringCA*

When a UE is configured for NR-DC operation and the UE is provided *monitoringCapabilityConfig* = *r16monitoringcapability* for all downlink cells where the UE monitors PDCCH, the UE may indicate, through *pdcch-BlindDetectionMCG-UE-r16* and *pdcch-BlindDetectionSCG-UE-r16*, respective maximum values for *pdcch-BlindDetection* for the MCG and *pdcch-BlindDetection* for the SCG.

If the UE reports *pdcch-MonitoringCA*,

- the value range of *pdcch-BlindDetectionMCG-UE-r16* or of *pdcch-BlindDetectionSCG-UE-r16* is [1, …, *pdcch-MonitoringCA*-1], and

- *pdcch-BlindDetectionMCG-UE-r16* + *pdcch-BlindDetectionSCG-UE-r16* >= *pdcch-MonitoringCA.*

Otherwise, if is a maximum total number of downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r16monitoringcapability* and the UE is configured on both the MCG and the SCG for NR-DC as indicated in *UE-NR-Capability*

- the value of *pdcch-BlindDetectionMCG-UE-r16* or of *pdcch-BlindDetectionSCG-UE-r16* is 1,

- *pdcch-BlindDetectionMCG-UE-r16* + *pdcch-BlindDetectionSCG-UE-r16* >= .

If a UE indicates in *UE-NR-Capability* a carrier aggregation capability larger than four downlink cells, the UE includes in *UE-NR-Capability* an indication for a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs that the UE can monitor per group of slots when the UE is configured for carrier aggregation operation over more than four downlink cells with SCS configuration . When a UE is not configured for NR-DC operation for all downlink cells where the UE monitors PDCCH, the UE determines a capability to monitor a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs per group of slots that corresponds to downlink cells, where

- is the number of configured downlink cells if the UE does not provide *pdcch-MonitoringCA-r17*

- otherwise, is the value of *pdcch-MonitoringCA-r17*

When the UE is configured for carrier aggregation operation over more than 4 cells, the UE does not expect to monitor per group of slots a number of PDCCH candidates or a number of non-overlapped CCEs that is larger than the maximum number as derived from the corresponding value of .

If a UE indicates in *UE-NR-Capability* a carrier aggregation capability larger than one downlink cell with *monitoringCapabilityConfig* = *r15monitoringcapability* or larger than one downlink cell with *monitoringCapabilityConfig* = *r16monitoringcapability*, the UE includes in *UE-NR-Capability* an indication for a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs the UE can monitor for downlink cells with *monitoringCapabilityConfig* = *r15monitoringcapability* or for downlink cells with *monitoringCapabilityConfig* = *r16monitoringcapability* when the UE is configured for carrier aggregation operation over more than two downlink cells with at least one downlink cell with *monitoringCapabilityConfig* = *r15monitoringcapability* and at least one downlink cell with *monitoringCapabilityConfig* = *r16monitoringcapability*. When a UE is not configured for NR-DC operation, the UE determines a capability to monitor a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs per slot or per span that corresponds to downlink cells or to downlink cells, respectively, where

- is the number of configured downlink cells if the UE does not provide *pdcch-BlindDetectionCA1*

- otherwise,

- if the UE reports only one combination of (*pdcch-BlindDetectionCA1*, *pdcch-BlindDetectionCA2*), is the value of *pdcch-BlindDetectionCA1*

- else, is the value of *pdcch-BlindDetectionCA1* from a combination of (*pdcch-BlindDetectionCA1, pdcch-BlindDetectionCA2*) that is provided by *pdcch-BlindDetectionCA-CombIndicator*

and

- is the number of configured downlink cells if the UE does not provide *pdcch-BlindDetectionCA2*

- otherwise,

- if the UE reports only one combination of (*pdcch-BlindDetectionCA1, pdcch-BlindDetectionCA2*), is the value of *pdcch-BlindDetectionCA2*

- else, is the value of *pdcch-BlindDetectionCA2* from a combination of (*pdcch-BlindDetectionCA1, pdcch-BlindDetectionCA2*) that is provided by *pdcch-BlindDetectionCA-CombIndicator*

If a UE indicates in *UE-NR-Capability* a carrier aggregation capability larger than one downlink cell with *monitoringCapabilityConfig* = *r15monitoringcapability* or larger than one downlink cell with *monitoringCapabilityConfig* = *r17monitoringcapability*, the UE includes in *UE-NR-Capability* an indication for a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs the UE can monitor for downlink cells with *monitoringCapabilityConfig* = *r15monitoringcapability* or for downlink cells with *monitoringCapabilityConfig* = *r17monitoringcapability* when the UE is configured for carrier aggregation operation over more than two downlink cells with at least one downlink cell with *monitoringCapabilityConfig* = *r15monitoringcapability* and at least one downlink cell has SCS configuration . When a UE is not configured for NR-DC operation, the UE determines a capability to monitor a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs per slot or per group of slots that corresponds to downlink cells or to downlink cells, respectively, where

- is the number of configured downlink cells if the UE does not provide *pdcch-BlindDetectionCAr15*

- otherwise,

- if the UE reports only one combination of (*pdcch-BlindDetectionCAr15*, *pdcch-BlindDetectionCAr17*), is the value of *pdcch-BlindDetectionCAr15*

- else, is the value of *pdcch-BlindDetectionCAr15* from a combination of (*pdcch-BlindDetectionCAr15, pdcch-BlindDetectionCAr17*) that is provided by *pdcch-BlindDetectionCA-CombIndicator-r17*

and

- is the number of configured downlink cells if the UE does not provide *pdcch-BlindDetectionCAr17*

- otherwise,

- if the UE reports only one combination of (*pdcch-BlindDetectionCAr15, pdcch-BlindDetectionCAr17*), is the value of *pdcch-BlindDetectionCAr17*

- else, is the value of *pdcch-BlindDetectionCAr17* from a combination of (*pdcch-BlindDetectionCAr15, pdcch-BlindDetectionCAr17*) that is provided by *pdcch-BlindDetectionCA-CombIndicator-r17*

If a UE indicates in *UE-NR-Capability* a carrier aggregation capability larger than one downlink cell with *monitoringCapabilityConfig* = *r16monitoringcapability* or larger than one downlink cell with *monitoringCapabilityConfig* = *r17monitoringcapability*, the UE includes in *UE-NR-Capability* an indication for a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs the UE can monitor for downlink cells with *monitoringCapabilityConfig* = *r16monitoringcapability* or for downlink cells with *monitoringCapabilityConfig* = *r17monitoringcapability* when the UE is configured for carrier aggregation operation over more than two downlink cells with at least one downlink cell with *monitoringCapabilityConfig* = *r16monitoringcapability* and at least one downlink cell has SCS configuration . When a UE is not configured for NR-DC operation, the UE determines a capability to monitor a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs per span or per group of slots that corresponds to downlink cells or to downlink cells, respectively, where

- is the number of configured downlink cells if the UE does not provide *pdcch-BlindDetectionCAr16*

- otherwise,

- if the UE reports only one combination of (*pdcch-BlindDetectionCAr16*, *pdcch-BlindDetectionCAr17*), is the value of *pdcch-BlindDetectionCAr16*

- else, is the value of *pdcch-BlindDetectionCAr16* from a combination of (*pdcch-BlindDetectionCAr16, pdcch-BlindDetectionCAr17*) that is provided by *pdcch-BlindDetectionCA-CombIndicator-r17*

and

- is the number of configured downlink cells if the UE does not provide *pdcch-BlindDetectionCAr17*

- otherwise,

- if the UE reports only one combination of (*pdcch-BlindDetectionCAr16, pdcch-BlindDetectionCAr17*), is the value of *pdcch-BlindDetectionCAr17*

- else, is the value of *pdcch-BlindDetectionCAr17* from a combination of (*pdcch-BlindDetectionCAr16, pdcch-BlindDetectionCAr17*) that is provided by *pdcch-BlindDetectionCA-CombIndicator-r17*

If a UE indicates in *UE-NR-Capability* a carrier aggregation capability larger than one downlink cell with *monitoringCapabilityConfig* = *r15monitoringcapability*, or larger than one downlink cell with *monitoringCapabilityConfig* = *r16monitoringcapability*, or larger than one downlink cell with *monitoringCapabilityConfig* = *r17monitoringcapability*, the UE includes in *UE-NR-Capability* an indication for a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs the UE can monitor for downlink cells with *monitoringCapabilityConfig* = *r15monitoringcapability*, or for downlink cells with *monitoringCapabilityConfig* = *r16monitoringcapability*, or for downlink cells with *monitoringCapabilityConfig* = *r17monitoringcapability* when the UE is configured for carrier aggregation operation over more than three downlink cells with at least one downlink cell with *monitoringCapabilityConfig* = *r15monitoringcapability*, at least one downlink cell with *monitoringCapabilityConfig* = *r16monitoringcapability* and at least one downlink cell has SCS configuration . When a UE is not configured for NR-DC operation, the UE determines a capability to monitor a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs per slot or per span or per group of slots that corresponds to downlink cells or to downlink cells or to downlink cells, respectively, where

- is the number of configured downlink cells if the UE does not provide *pdcch-BlindDetectionCAr15*

- otherwise,

- if the UE reports only one combination of (*pdcch-BlindDetectionCAr15*, *pdcch-BlindDetectionCAr16*, *pdcch-BlindDetectionCAr17*), is the value of *pdcch-BlindDetectionCAr15*

- else, is the value of *pdcch-BlindDetectionCAr15* from a combination of (*pdcch-BlindDetectionCAr15*, *pdcch-BlindDetectionCAr16, pdcch-BlindDetectionCAr17*) that is provided by *pdcch-BlindDetectionCA-CombIndicator-r17*

- is the number of configured downlink cells if the UE does not provide *pdcch-BlindDetectionCAr16*

- otherwise,

- if the UE reports only one combination of (*pdcch-BlindDetectionCAr15*, *pdcch-BlindDetectionCAr16*, *pdcch-BlindDetectionCAr17*), is the value of *pdcch-BlindDetectionCAr16*

- else, is the value of *pdcch-BlindDetectionCAr16* from a combination of (*pdcch-BlindDetectionCAr15*, *pdcch-BlindDetectionCAr16, pdcch-BlindDetectionCAr17*) that is provided by *pdcch-BlindDetectionCA-CombIndicator-r17*

and

- is the number of configured downlink cells if the UE does not provide *pdcch-BlindDetectionCAr17*

- otherwise,

- if the UE reports only one combination of (*pdcch-BlindDetectionCAr15*, *pdcch-BlindDetectionCAr16, pdcch-BlindDetectionCAr17*), is the value of *pdcch-BlindDetectionCAr17*

- else, is the value of *pdcch-BlindDetectionCAr17* from a combination of (*pdcch-BlindDetectionCAr15*, *pdcch-BlindDetectionCAr16, pdcch-BlindDetectionCAr17*) that is provided by *pdcch-BlindDetectionCA-CombIndicator-r17*

When a UE is configured for NR-DC operation and is provided *monitoringCapabilityConfig* = *r15monitoringcapability* for at least one downlink cell and *monitoringCapabilityConfig* = *r16monitoringcapability* for at least one downlink cell where the UE monitors PDCCH, the UE determines a capability to monitor a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs that corresponds to

- downlink cells for the MCG where is provided by *pdcch-BlindDetection3* for the MCG,

- downlink cells for the SCG where is provided by *pdcch-BlindDetection3* for the SCG, and

- downlink cells for the MCG where is provided by *pdcch-BlindDetection2* for the MCG,

- downlink cells for the SCG where is provided by *pdcch-BlindDetection2* for the SCG

When a UE is configured for carrier aggregation operation over more than two downlink cells with at least one downlink cell with *monitoringCapabilityConfig* = *r15monitoringcapability*, at least one downlink cell with *monitoringCapabilityConfig* = *r16monitoringcapability*, and no downlink cell has SCS configuration , or for a cell group when the UE is configured for NR-DC operation, the UE does not expect to

- monitor per slot a number of PDCCH candidates or a number of non-overlapped CCEs that is larger than the maximum number as derived from the corresponding value of , and

- monitor per span a number of PDCCH candidates or a number of non-overlapped CCEs that is larger than the maximum number as derived from the corresponding value of

When the UE is configured for carrier aggregation operation over more than two downlink cells with at least one downlink cell with *monitoringCapabilityConfig* = *r15monitoringcapability*, at least one downlink cell with SCS configuration , and no downlink cell with *monitoringCapabilityConfig* = *r16monitoringcapability*, the UE does not expect to

- monitor per slot a number of PDCCH candidates or a number of non-overlapped CCEs that is larger than the maximum number as derived from the corresponding value of , and

- monitor per group of slots a number of PDCCH candidates or a number of non-overlapped CCEs that is larger than the maximum number as derived from the corresponding value of

When the UE is configured for carrier aggregation operation over more than two downlink cells with at least one downlink cell with *monitoringCapabilityConfig* = *r16monitoringcapability*, at least one downlink cell with SCS configuration , and no downlink cell with *monitoringCapabilityConfig* = *r15monitoringcapability*, the UE does not expect to

- monitor per span a number of PDCCH candidates or a number of non-overlapped CCEs that is larger than the maximum number as derived from the corresponding value of , and

- monitor per group of slots a number of PDCCH candidates or a number of non-overlapped CCEs that is larger than the maximum number as derived from the corresponding value of

When the UE is configured for carrier aggregation operation over more than three downlink cells with at least one downlink cell with *monitoringCapabilityConfig* = *r15monitoringcapability*, at least one downlink cell with *monitoringCapabilityConfig* = *r16monitoringcapability*, and at least one downlink cell with SCS configuration , the UE does not expect to

- monitor per slot a number of PDCCH candidates or a number of non-overlapped CCEs that is larger than the maximum number as derived from the corresponding value of , and

- monitor per span a number of PDCCH candidates or a number of non-overlapped CCEs that is larger than the maximum number as derived from the corresponding value of , and

- monitor per group of slots a number of PDCCH candidates or a number of non-overlapped CCEs that is larger than the maximum number as derived from the corresponding value of

When a UE is configured for NR-DC operation with a total of downlink cells on both the MCG and the SCG and the UE is provided *monitoringCapabilityConfig* = *r15monitoringcapability* for downlink cells and *monitoringCapabilityConfig* = *r16monitoringcapability* for downlink cells where the UE monitors PDCCH, the UE expects to be provided *pdcch-BlindDetection3* and *pdcch-BlindDetection2* for the MCG, and *pdcch-BlindDetection3* and *pdcch-BlindDetection2* for the SCG with values that satisfy

- *pdcch-BlindDetection3* for the MCG + *pdcch-BlindDetection3* for the SCG <= *pdcch-BlindDetectionCA1*, if the UE reports *pdcch-BlindDetectionCA1*, or

- *pdcch-BlindDetection3* for the MCG + *pdcch-BlindDetection3* for the SCG <= , if the UE does not report *pdcch-BlindDetectionCA1*

and

- *pdcch-BlindDetection2* for the MCG + *pdcch-BlindDetection2* for the SCG <= *pdcch-BlindDetectionCA2*, if the UE reports *pdcch-BlindDetectionCA2*, or

- *pdcch-BlindDetection2* for the MCG + *pdcch-BlindDetection2* for the SCG <= , if the UE does not report *pdcch-BlindDetectionCA2*

When a UE is configured for NR-DC operation and is provided *monitoringCapabilityConfig* = *r15monitoringcapability* for at least one downlink cell and *monitoringCapabilityConfig* = *r16monitoringcapability* for at least one downlink cell where the UE monitors PDCCH, the UE may indicate, through *pdcch-BlindDetectionMCG-UE1* and *pdcch-BlindDetectionSCG-UE1*, respective maximum values for *pdcch-BlindDetection3* for the MCG and *pdcch-BlindDetection3* for the SCG, and through *pdcch-BlindDetectionMCG-UE2* and *pdcch-BlindDetectionSCG-UE2* respective maximum values for *pdcch-BlindDetection2* for the MCG and *pdcch-BlindDetection2* for the SCG.

If the UE reports *pdcch-BlindDetectionCA1*,

- the value range of *pdcch-BlindDetectionMCG-UE1* or of *pdcch-BlindDetectionSCG-UE1* is [0, 1, …, *pdcch-BlindDetectionCA1*], and

- *pdcch-BlindDetectionMCG-UE1* + *pdcch-BlindDetectionSCG-UE1* >= *pdcch-BlindDetectionCA1*.

Otherwise, if is a maximum total number of downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r15monitoringcapability* and the UE is configured on both the MCG and the SCG for NR-DC as indicated in *UE-NR-Capability*

- the value range of *pdcch-BlindDetectionMCG-UE1* or of *pdcch-BlindDetectionSCG-UE1* is [0, 1, 2],

- *pdcch-BlindDetectionMCG-UE1* + *pdcch-BlindDetectionSCG-UE1* >= .

If the UE reports *pdcch-BlindDetectionCA2*

- the value range of *pdcch-BlindDetectionMCG-UE2* or of *pdcch-BlindDetectionSCG-UE2* is [0, 1, …, *pdcch-BlindDetectionCA2*], and

- *pdcch-BlindDetectionMCG-UE2* + *pdcch-BlindDetectionSCG-UE2* >= *pdcch-BlindDetectionCA2.*

Otherwise, if is a maximum total number of downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r16monitoringcapability* and the UE is configured on both the MCG and the SCG for NR-DC as indicated in *UE-NR-Capability*

- the value range of *pdcch-BlindDetectionMCG-UE2* or of *pdcch-BlindDetectionSCG-UE2* is [0, 1],

- *pdcch-BlindDetectionMCG-UE2* + *pdcch-BlindDetectionSCG-UE2* >= .

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

\*\*\* Unchanged text is omitted \*\*\*

If the UE is provided by *simultaneousTCI-UpdateList1* or *simultaneousTCI-UpdateList2* up to two lists of cells for simultaneous TCI state activation, the UE applies the antenna port quasi co-location provided by one or two *TCI-State* each with same activated *tci-StateID* value, to CORESETs with a same index in all configured DL BWPs of all configured cells in a list determined from a serving cell index, where one or two *tci-StateID*, the CORESET index, and the serving cell index are provided by a MAC CE command.

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

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

- an association between the search space set and a CORESET by *controlResourceSetId* or by *controlResourceSetId-v1610*

- a PDCCH monitoring periodicity of slots and a PDCCH monitoring offset of slots, by *monitoringSlotPeriodicityAndOffset* or by *monitoringSlotPeriodicityAndOffset-r17*

- is an integer multiple of the size of *monitoringSlotsWithinSlotGroup*, if provided

- a PDCCH monitoring pattern within a slot, indicating first symbol(s) of the CORESET for PDCCH monitoring within each slot where the UE monitors PDCCH, by *monitoringSymbolsWithinSlot*

- a duration of indicating a number of slots that the search space set exists by *duration*, or a number of slots in consecutive groups of slots where the search space set can exist by *duration-r17*

- a bitmap, by *monitoringSlotsWithinSlotGroup*, that applies per group of slots and provides a PDCCH monitoring pattern indicating slots in a group of slots for PDCCH monitoring

- a size of the group of slots is same as a size of *monitoringSlotsWithinSlotGroup*

- for a Type1-PDCCH CSS set provided by *ra-SearchSpace* in dedicated RRC signaling, or for a Type3-PDCCH CSS set, or for a USS set, the PDCCH monitoring pattern indicates only consecutive slots in the group of slots for PDCCH monitoring and, at least for one combination indicated by the UE as a capability, a number of the consecutive slots is not larger than

- a number of PDCCH candidates per CCE aggregation level by *aggregationLevel1*, *aggregationLevel2*, *aggregationLevel4*, *aggregationLevel8*, and *aggregationLevel16*, for CCE aggregation level 1, CCE aggregation level 2, CCE aggregation level 4, CCE aggregation level 8, and CCE aggregation level 16, respectively

- an indication that search space set is either a CSS set or a USS set by *searchSpaceType*

- if search space set is a CSS set

- an indication by *dci-Format0-0-AndFormat1-0* to monitor PDCCH candidates for DCI format 0\_0 and DCI format 1\_0

- an indication by *dci-Format2-0* to monitor one or two PDCCH candidates, or to monitor one PDCCH candidate per RB set if the UE is provided *freqMonitorLocations* for the search space set, for DCI format 2\_0 and a corresponding CCE aggregation level

- an indication by *dci-Format2-1* to monitor PDCCH candidates for DCI format 2\_1

- an indication by *dci-Format2-2* to monitor PDCCH candidates for DCI format 2\_2

- an indication by *dci-Format2-3* to monitor PDCCH candidates for DCI format 2\_3

- an indication by *dci-Format2-4* to monitor PDCCH candidates for DCI format 2\_4

- an indication by *dci-Format2-6* to monitor PDCCH candidates for DCI format 2\_6

- an indication by *dci-Format4-0* to monitor PDCCH candidates for DCI format 4\_0

- an indication by *dci-Format4-1*, or *dci-Format4-2*, or *dci-Format4-1-AndFormat4-2* to monitor PDCCH candidates for DCI format 4\_1, or DCI format 4\_2, or for both DCI format 4\_1 and DCI format 4\_2, respectively

- a search space set index by *searchSpaceLinking* for another search space set that is linked to search space set

- if search space set is a USS set, an indication by *dci-Formats* to monitor PDCCH candidates either for DCI format 0\_0 and DCI format 1\_0, or for DCI format 0\_1 and DCI format 1\_1, or an indication by *dci-FormatsExt* to monitor PDCCH candidates for DCI format 0\_2 and DCI format 1\_2, or for DCI format 0\_1, DCI format 1\_1, DCI format 0\_2, and DCI format 1\_2, or an indication by *dci-FormatsSL* to monitor PDCCH candidates for DCI format 0\_0 and DCI format 1\_0, or for DCI format 0\_1 and DCI format 1\_1, or for DCI format 3\_0, or for DCI format 3\_1, or for DCI format 3\_0 and DCI format 3\_1

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

If the *monitoringSymbolsWithinSlot* indicates to a UE to monitor PDCCH in a subset of up to three consecutive symbols that are same in every slot where the UE monitors PDCCH for all search space sets, the UE does not expect to be configured with a PDCCH SCS other than 15 kHz if the subset includes at least one symbol after the third symbol.

A UE does not expect to be provided a first symbol and a number of consecutive symbols for a CORESET that results to a PDCCH candidate mapping to symbols of different slots.

A UE does not expect any two PDCCH monitoring occasions on an active DL BWP, for a same search space set or for different search space sets, in a same CORESET to be separated by a non-zero number of symbols that is smaller than the CORESET duration.

A UE determines a PDCCH monitoring occasion on an active DL BWP from the PDCCH monitoring periodicity, the PDCCH monitoring offset, and the PDCCH monitoring pattern within a slot. For search space set , the UE determines that PDCCH monitoring occasions exist in a slot with number [4, TS 38.211] in a frame with number  if ( +-). If *monitoringSlotsWithinSlotGroup* is provided, the slot is the first slot in a group of slots and PDCCH monitoring occasions exist in the group of slots. The UE monitors PDCCH candidates for search space set for consecutive slots, starting from slot , and does not monitor PDCCH candidates for search space set for the next  consecutive slots.

A USS at CCE aggregation level is defined by a set of PDCCH candidates for CCE aggregation level .

If a UE is configured with *CrossCarrierSchedulingConfig* for a serving cell the carrier indicator field value corresponds to the value indicated by *CrossCarrierSchedulingConfig.*

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

A UE does not expect to monitor PDCCH candidates on an active DL BWP of a secondary cell if the UE is configured to monitor PDCCH candidates with carrier indicator field corresponding to that secondary cell in another serving cell. For the active DL BWP of a serving cell on which the UE monitors PDCCH candidates, the UE monitors PDCCH candidates at least for the same serving cell.

For a search space set associated with CORESET , the CCE indexes for aggregation level corresponding to PDCCH candidate of the search space set in slot for an active DL BWP of a serving cell corresponding to carrier indicator field value are given by

where

for any CSS, ;

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

;

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

is the carrier indicator field value if the UE is configured with a carrier indicator field by *CrossCarrierSchedulingConfig* for the serving cell on which PDCCH is monitored; otherwise, including for any CSS, ;

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

for any CSS, ;

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

the RNTI value used for is the C-RNTI.

For search space sets and that include *searchSpaceLinking* with value and , respectively, a UE monitors, in monitoring occasions with same index according to each of search space sets and in a slot, PDCCH candidates and , with , for detection of a DCI format with same information. The UE expects , , , and a same number of non-overlapping PDCCH monitoring occasions per slot based on corresponding *monitoringSymbolsWithinSlot*, for search space sets and . For CORESET associated with the search space set and for CORESET associated with the search space set , the UE is provided *tci-PresentInDCI* or tci-PresentDCI-1-2 for either none or both of CORESETs and . For CORESET associated with the search space set and for CORESET associated with the search space set , the UE is either not provided coresetPoolIndex value of 1 for any of the two CORESETs, or is provided coresetPoolIndex value of 1 for both CORESETs. The UE can indicate by countLinkedCandidates a capability for counting PDCCH candidates and either as 2 PDCCH candidates or as 3 PDCCH candidates. For search space sets , , , and , that include *searchSpaceLinking* with values , , , and , respectively, a UE expects to simultaneously monitor PDCCH candidates , and = only if a first CCE of or has different index than a first CCE of or in a CORESET configured with *cce-REG-MappingType* = '*nonInterleaved*' and with duration of one symbol.

If a UE

- is provided *monitoringCapabilityConfig* = *r16monitoringcapability* for a downlink cell,

- is provided, by *searchSpaceLinking*, for search space sets and on the downlink cell respective values and , and

- indicates *three-BDforSSsetLinking*

the UE counts each PDCCH candidate for the one of the search space sets and that the UE monitors PDCCH in the later span, as two PDCCH candidates.

A UE does not expect to be provided *freqMonitorLocations* for a search space set in a serving cell if *intraCellGuardBandsDL-List* indicates that no intra-cell guard-bands are configured for the serving cell.

A UE that

- is configured for operation with carrier aggregation, and

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

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

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

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

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

A UE expects to monitor PDCCH candidates for up to 4 sizes of DCI formats that include up to 3 sizes of DCI formats with CRC scrambled by C-RNTI per serving cell. The UE counts a number of sizes for DCI formats per serving cell based on a number of configured PDCCH candidates in respective search space sets for the corresponding active DL BWP.

A UE does not expect to detect, in a same PDCCH monitoring occasion, a DCI format with CRC scrambled by a SI-RNTI, RA-RNTI, MsgB-RNTI, TC-RNTI, P-RNTI, C-RNTI, CS-RNTI, or MCS-RNTI and a DCI format with CRC scrambled by a SL-RNTI or a SL-CS-RNTI for scheduling respective PDSCH reception and PSSCH transmission on a same serving cell.

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

For search space sets and that include *searchSpaceLinking* with values and , and for search space set that does not include *searchSpaceLinking*, when a UE

- monitors PDCCH candidates for detection of a first DCI format,

- monitors PDCCH candidate for detection of a second DCI format having a same size as the first DCI format,

- the PDCCH candidate , or the PDCCH candidate , and the PDCCH candidate have identical scrambling and use a same set of CCEs over same symbols in a slot in a CORESET ,

the PDCCH candidate is not counted for monitoring and the UE assumes that a detected DCI format is the first DCI format. A UE may monitor PDCCH candidate depending on a corresponding capability [16, TS 38.306]. For search space sets and that include *searchSpaceLinking* with values and , and for search space set that does not include *searchSpaceLinking*, when a UE

- monitors PDCCH candidates for detection of a first DCI format and monitors PDCCH candidate for detection of a second DCI format, or monitors PDCCH candidates for detection of the first DCI format and monitors PDCCH candidate for detection of the second DCI format, and

- one of the PDCCH candidates and , and the PDCCH candidate , or one of the PDCCH candidates and , and the PDCCH candidate , have a first CCE with same index and are simultaneously monitored in a CORESET with *cce-REG-MappingType* = '*nonInterleaved*' and duration of one symbol,

the UE assumes that a detected DCI format is the first DCI format.

For search space sets , , , and that include *searchSpaceLinking* with values , , , and , respectively, and for detection of DCI formats with same size, a UE expects different CCEs or different scrambling in a CORESET for any of first PDCCH candidates and , with , and any of second PDCCH candidates and , with that the UE would simultaneously monitor.

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

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

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

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

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

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

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

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

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

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

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

- different CORESET indexes, or

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

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

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

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

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

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

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

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

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

If a UE

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

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

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

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

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

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

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

If a UE

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

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

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

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

For each scheduled cell from the downlink cells, the UE is not required to monitor on the active DL BWP with SCS configuration of the scheduling cell more than PDCCH candidates or more than non-overlapped CCEs per slot.

For each scheduled cell from the downlink cells, the UE is not required to monitor on the active DL BWP with SCS configuration of the scheduling cell

- more than PDCCH candidates or more than non-overlapped CCEs per slot

- more than PDCCH candidates or more than non-overlapped CCEs per slot for CORESETs with same *coresetPoolIndex* value

If a UE is configured with downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r16monitoringcapability* and with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cells using SCS configuration , and with of the downlink cells using combination for PDCCH monitoring, where , the UE is not required to monitor, on the active DL BWP of the scheduling cell, more than PDCCH candidates or more than non-overlapped CCEs per span for each scheduled cell when the scheduling cell is from the downlink cells. If a UE is configured with downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r15monitoringcapability* and *monitoringCapabilityConfig* = *r16monitoringcapability*, is replaced by .

If a UE is configured only with downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r16monitoringcapability* and with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cells using SCS configuration , and with of the downlink cells using combination for PDCCH monitoring, where , a DL BWP of an activated cell is the active DL BWP of the activated cell, and a DL BWP of a deactivated cell is the DL BWP with index provided by *firstActiveDownlinkBWP-Id* for the deactivated cell, the UE is not required to monitor more than PDCCH candidates or more than non-overlapped CCEs

- per set of spans on the active DL BWP(s) of all scheduling cell(s) from the downlink cells within every symbols, if the union of PDCCH monitoring occasions on all scheduling cells from the downlink cells results to PDCCH monitoring according to the combination and any pair of spans in the set is within symbols, where first symbols start at a first symbol with a PDCCH monitoring occasion and next symbols start at a first symbol with a PDCCH monitoring occasion that is not included in the first symbols

- per set of spans across the active DL BWP(s) of all scheduling cells from the downlink cells, with at most one span per scheduling cell for each set of spans, otherwise

where is a number of configured cells with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cells using SCS configuration . If a UE is configured with downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r15monitoringcapability* and *monitoringCapabilityConfig* = *r16monitoringcapability*, is replaced by .

For each scheduled cell from the downlink cells using combination , the UE is not required to monitor on the active DL BWP with SCS configuration of the scheduling cell, more than PDCCH candidates or more than non-overlapped CCEs per span.

A UE does not expect to be configured CSS sets, except for CSS sets provided by *searchSpace-Multicast*, that result to corresponding total, or per scheduled cell, numbers of monitored PDCCH candidates and non-overlapped CCEs per slot, per group of slots for a corresponding combination , or per span that exceed the corresponding maximum numbers per slot, or per group of slots for a corresponding combination , or per span, respectively.

For same cell scheduling or for cross-carrier scheduling, a UE does not expect a number of PDCCH candidates, and a number of corresponding non-overlapped CCEs per slot, or per group of slots for a corresponding combination , or per span, on a secondary cell to be larger than the corresponding numbers that the UE is capable of monitoring on the secondary cell per slot, or per group of slots for a corresponding combination , or per span, respectively. If a UE is provided *monitoringCapabilityConfig* = *r16monitoringcapability* for the primary cell, except the first span of each slot, the UE does not expect a number of PDCCH candidates and a number of corresponding non-overlapped CCEs per span on the primary cell to be larger than the corresponding numbers that the UE is capable of monitoring on the primary cell per span.

If a UE is configured with downlink cells with SCS configuration in the active DL BWPs of the scheduling cells, and with of the downlink cells using combination , for PDCCH monitoring, where , the UE is not required to monitor, on the active DL BWP of the scheduling cell, more than PDCCH candidates or more than non-overlapped CCEs per group of slots for each scheduled cell when the scheduling cell is from the downlink cells. If the UE is configured with downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r15monitoringcapability* and downlink cells with SCS configuration for the active DL BWPs, is replaced by . If the UE is configured with downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r16monitoringcapability* and downlink cells with SCS configuration for the active DL BWPs, is replaced by . If the UE is configured with downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r15monitoringcapability* and *monitoringCapabilityConfig* = *r16monitoringcapability* and downlink cells with SCS configuration for the active DL BWPs, is replaced by .

If a UE is configured downlink cells with SCS configuration for the active DL BWPs of the scheduling cells, and with of the downlink cells using combination for PDCCH monitoring, where , a DL BWP of an activated cell is the active DL BWP of the activated cell, and a DL BWP of a deactivated cell is the DL BWP with index provided by *firstActiveDownlinkBWP-Id* for the deactivated cell, the UE is not required to monitor more than PDCCH candidates, or more than non-overlapped CCEs, per group of slots on the active DL BWP(s) of scheduling cell(s) from the downlink cells where is a number of configured cells with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cells using SCS configuration . If the UE is configured downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r15monitoringcapability* or *monitoringCapabilityConfig* = *r16monitoringcapability*, or *monitoringCapabilityConfig* = *r15monitoringcapability* and at least one downlink cells has SCS configuration for the active DL BWP, is replaced by , or by , or by , respectively, and , , and is one of , , or , respectively.

For each scheduled cell from the downlink cells using combination , the UE is not required to monitor on the active DL BWP with SCS configuration of the scheduling cell, more than PDCCH candidates or more than non-overlapped CCEs per group of slots.

For cross-carrier scheduling, the number of PDCCH candidates for monitoring and the number of non-overlapped CCEs per span or per slot or per group of slots are separately counted for each scheduled cell.

The UE allocates PDCCH candidates for monitoring to USS sets for the primary cell having an active DL BWP with SCS configuration in a slot if the UE is not provided *monitoringCapabilityConfig* for the primary cell or if the UE is provided *monitoringCapabilityConfig* = *r15monitoringcapability* for the primary cell, or in the first span of each slot if the UE is provided *monitoringCapabilityConfig* = *r16monitoringcapability* for the primary cell, or in a group of slots for a corresponding combination if the UE is provided *monitoringCapabilityConfig* = *r17monitoringcapability* for the primary cell, according to the following pseudocode.

If for the USS sets for scheduling on the primary cell the UE is not provided *coresetPoolIndex* for first CORESETs, or is provided *coresetPoolIndex* with value 0 for first CORESETs, and is provided *coresetPoolIndex* with value 1 for second CORESETs, and if or , the following pseudocode applies only to USS sets associated with the first CORESETs. A UE does not expect to monitor PDCCH in a USS set without allocated PDCCH candidates for monitoring.

In the following pseudocode, if the UE is provided *monitoringCapabilityConfig* = *r16monitoringcapability* for the primary cell,and are replaced by and respectively, and and are replaced by and respectively.

In the following pseudocode, if the UE is provided *monitoringCapabilityConfig* = *r17monitoringcapability* for the primary cell,and are replaced by and respectively, and and are replaced by and respectively.

For all search space sets within a slot , or within a group of slots for a corresponding combination , or within a span in slot , denote by a set of CSS sets, except for CSS sets provided by *searchSpace-Multicast*, with cardinality of and by a set of USS sets and CSS sets provided by *searchSpace-Multicast* with cardinality of . The location of search space sets , , in is according to an ascending order of the search space set index.

Denote by , , the number of counted PDCCH candidates for monitoring for CSS set and by , , the number of counted PDCCH candidates for monitoring for search space set . If a UE indicates *three-BDforSSsetLinking* and is provided for search space set , by *searchSpaceLinking*, a search space set with , set if and are CSS sets or set if and are USS sets.

For the CSS sets in , a UE monitors PDCCH candidates requiring a total of non-overlapping CCEs in a slot, of in group of slots for a corresponding combination , or in a span.

Denote by the set of non-overlapping CCEs for search space set and by ; the cardinality of where a UE determines the non-overlapping CCEs for search space set considering the allocated PDCCH candidates for monitoring for the CSS sets in and the allocated PDCCH candidates for monitoring for all search space sets , .

Set

Set

Set

while AND

allocate PDCCH candidates for monitoring to search space set

;

;

;

end while

If a UE

- is configured for single cell operation or for operation with carrier aggregation in a same frequency band, and

- monitors PDCCH candidates in overlapping PDCCH monitoring occasions in multiple CORESETs that have been configured with same or different *qcl-Type* set to 'typeD' properties on active DL BWP(s) of one or more cells

the UE monitors PDCCHs only in a CORESET, and in any other CORESET from the multiple CORESETs that have been configured with *qcl-Type* set to same 'typeD' properties as the CORESET, on the active DL BWP of a cell from the one or more cells

- the CORESET corresponds to the CSS set with the lowest index in the cell with the lowest index containing CSS, if any; otherwise, to the USS set with the lowest index in the cell with lowest index

- the lowest USS set index is determined over all USS sets with at least one PDCCH candidate in overlapping PDCCH monitoring occasions

If a UE

- is configured for single cell operation or for operation with carrier aggregation in a same frequency band,

- monitors PDCCH candidates in overlapping PDCCH monitoring occasions in multiple CORESETs that have been configured with same or different *qcl-Type* set to 'typeD' properties on active DL BWP(s) of one or more cells, and

- is provided *two-QCLTypeDforPDCCHRepetition*

the UE monitors PDCCHs only in a first CORESET with *qcl-Type* set to first 'typeD' properties and, if any, in a second CORESET with *qcl-Type* set to second 'typeD' properties that are different than the first 'typeD' properties, and in any other CORESET from the multiple CORESETs with corresponding *qcl-Type* set to the first 'typeD' properties and/or to the second 'typeD' properties

- the first CORESET corresponds to the CSS set with the lowest index in the cell with the lowest index containing CSS sets, if any; otherwise, to the USS set with the lowest index in the cell with lowest index

- excluding CSS sets and USS sets associated with CORESETs with *qcl-Type* set to first 'typeD' properties, the second CORESET corresponds to the CSS set with the lowest index in the cell with the lowest index containing CSS sets; if any; otherwise, to the USS set with the lowest index in the cell with lowest index, where the CSS set or the USS set includes *searchSpaceLinking* with a value indicating, respectively, any CSS set or any USS set associated with CORESETs with *qcl-Type* set to first 'typeD' properties

- the lowest USS set index is determined over all USS sets with at least one PDCCH candidate in overlapping PDCCH monitoring occasions

If a UE

- is configured for single cell operation or for operation with carrier aggregation in a same frequency band,

- monitors PDCCH candidates in overlapping PDCCH monitoring occasions in multiple CORESETs that have been configured with same or different *qcl-Type* set to 'typeD' properties on active DL BWP(s) of one or more cells,

- one or more CORESETs have two activated TCI states, and

- reports *twoTypeDcapabilityname*

the UE monitors PDCCHs only in a CORESET with a first *qcl-Type* set to first 'typeD' properties and, if any, a second *qcl-Type* set to second 'typeD' properties that are different than the first 'typeD' properties, and in any other CORESET from the multiple CORESETs with corresponding *qcl-Type* set to the first 'typeD' properties or to the second 'typeD' properties

- the CORESET corresponds to the CSS set with the lowest index in the cell with the lowest index containing CSS, if any; otherwise, to the USS set with the lowest index in the cell with lowest index

- the lowest USS set index is determined over all USS sets with at least one PDCCH candidate in overlapping PDCCH monitoring occasions

For the purpose of determining the CORESET, a SS/PBCH block is considered to have different QCL 'typeD' properties than a CSI-RS.

For the purpose of determining the CORESET, a first CSI-RS associated with a SS/PBCH block in a first cell and a second CSI-RS in a second cell that is also associated with the SS/PBCH block are assumed to have same QCL 'typeD' properties.

The allocation of non-overlapping CCEs and of PDCCH candidates for PDCCH monitoring is according to all search space sets associated with the multiple CORESETs on the active DL BWP(s) of the one or more cells.

The number of active TCI states is determined from the multiple CORESETs.

If a UE

- is configured for single cell operation or for operation with carrier aggregation in a same frequency band, and

- monitors PDCCH candidates in overlapping PDCCH monitoring occasions in multiple CORESETs where none of the CORESETs has TCI-states configured with *qcl-Type* set to 'typeD',

the UE is required to monitor PDCCH candidates in overlapping PDCCH monitoring occasions for search space sets associated with different CORESETs.

For a scheduled cell and at any time, a UE expects to have received at most 16 PDCCHs for DCI formats with CRC scrambled by C-RNTI, CS-RNTI, or MCS-C-RNTI scheduling 16 PDSCH receptions for which the UE has not received any corresponding PDSCH symbol and at most 16 PDCCHs for DCI formats with CRC scrambled by C-RNTI, CS-RNTI, or MCS-C-RNTI scheduling 16 PUSCH transmissions for which the UE has not transmitted any corresponding PUSCH symbol.

If a UE is not provided *monitoringCapabilityConfig* = *r16monitoringcapability* for any serving cell, and

- is not configured for NR-DC operation and indicates through *pdcch-BlindDetectionCA* a capability to monitor PDCCH candidates for downlink cells and the UE is configured with downlink cells or uplink cells, or

- is configured with NR-DC operation and for a cell group with downlink cells or uplink cells

the UE expects to have respectively received at most PDCCHs for

- DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PDSCH receptions for which the UE has not received any corresponding PDSCH symbol over all downlink cells

- DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PUSCH transmissions for which the UE has not transmitted any corresponding PUSCH symbol over all uplink cells

If a UE is provided *monitoringCapabilityConfig* = *r16monitoringcapability* for all serving cells*,* and

- is not configured for NR-DC operation and indicates through *pdcch-MonitoringCA* a capability to monitor PDCCH candidates for downlink cells and the UE is configured with downlink cells or uplink cells, or

- is configured with NR-DC operation and for a cell group with downlink cells or uplink cells

the UE expects to have respectively received at most PDCCHs for

- DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PDSCH receptions for which the UE has not received any corresponding PDSCH symbol over all downlink cells

- DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PUSCH transmissions for which the UE has not transmitted any corresponding PUSCH symbol over all uplink cells.

If a UE is provided *monitoringCapabilityConfig* = *r16monitoringcapability* for at least one serving cell and is not provided *monitoringCapabilityConfig* = *r16monitoringcapability* for at least one serving cell,and

- is not configured for NR-DC operation, and indicates a capability to monitor PDCCH candidates for downlink cells and downlink cells, and the UE is configured with downlink cell or uplink cells, or

- is configured with NR-DC operation and for a cell group with downlink cells or uplink cells

the UE expects to have respectively received

- at most PDCCHs for DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PDSCH receptions for which the UE has not received any corresponding PDSCH symbol over all serving cells that are not provided *monitoringCapabilityConfig* = *r16monitoringcapability*

- at most PDCCHs for DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PUSCH transmissions for which the UE has not transmitted any corresponding PUSCH symbol over all serving cells that are not provided *monitoringCapabilityConfig* = *r16monitoringcapability*

- at most PDCCHs for DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PDSCH receptions for which the UE has not received any corresponding PDSCH symbol over all serving cells that are provided *monitoringCapabilityConfig* = *r16monitoringcapability*

- at most PDCCHs for DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PUSCH transmissions for which the UE has not transmitted any corresponding PUSCH symbol over all serving cells that are provided *monitoringCapabilityConfig* = *r16monitoringcapability*

If a UE is provided serving cells with SCS configuration for the active DL BWP, is not configured for NR-DC operation and indicates through *pdcch-MonitoringCA* a capability to monitor PDCCH candidates for downlink cells and the UE is configured with downlink cells or uplink cells, the UE expects to have respectively received at most PDCCHs for

- DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PDSCH receptions for which the UE has not received any corresponding PDSCH symbol over all downlink cells

- DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PUSCH transmissions for which the UE has not transmitted any corresponding PUSCH symbol over all uplink cells.

If a UE has SCS configuration for the active DL BWP for at least one serving cell, is provided *monitoringCapabilityConfig* = *r15monitoringcapability* for at least one serving cell, is not provided *monitoringCapabilityConfig* = *r16monitoringcapability* for any serving cell, is not configured for NR-DC operation, indicates a capability to monitor PDCCH candidates for downlink cells and downlink cells, and UE is configured with downlink cell or uplink cells, the UE expects to have respectively received

- at most PDCCHs for DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PDSCH receptions for which the UE has not received any corresponding PDSCH symbol over all serving cells that are provided *monitoringCapabilityConfig* = *r15monitoringcapability*

- at most PDCCHs for DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PUSCH transmissions for which the UE has not transmitted any corresponding PUSCH symbol over all serving cells that are provided *monitoringCapabilityConfig* = *r15monitoringcapability*

- at most PDCCHs for DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PDSCH receptions for which the UE has not received any corresponding PDSCH symbol over all serving cells with SCS configuration

- at most PDCCHs for DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PUSCH transmissions for which the UE has not transmitted any corresponding PUSCH symbol over all serving cells with SCS configuration

If a UE has SCS configuration for the active DL BWP of at least one serving cell, is provided *monitoringCapabilityConfig* = *r16monitoringcapability* for at least one serving cell, is not provided *monitoringCapabilityConfig* = *r15monitoringcapability* for any serving cell, is not configured for NR-DC operation, indicates a capability to monitor PDCCH candidates for downlink cells and downlink cells, and the UE is configured with downlink cells or uplink cells

the UE expects to have respectively received

- at most PDCCHs for DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PDSCH receptions for which the UE has not received any corresponding PDSCH symbol over all serving cells that are provided *monitoringCapabilityConfig* = *r16monitoringcapability*

- at most PDCCHs for DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PUSCH transmissions for which the UE has not transmitted any corresponding PUSCH symbol over all serving cells that are provided *monitoringCapabilityConfig* = *r16monitoringcapability*

- at most PDCCHs for DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PDSCH receptions for which the UE has not received any corresponding PDSCH symbol over all serving cells with SCS configuration

- at most PDCCHs for DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PUSCH transmissions for which the UE has not transmitted any corresponding PUSCH symbol over all serving cells with SCS configuration

If a UE has SCS configuration for the active DL BWP of at least one serving cell, is provided *monitoringCapabilityConfig* = *r16monitoringcapability* for at least one serving cell, and *monitoringCapabilityConfig* = *r15monitoringcapability* for at least one serving cell, is not configured for NR-DC operation, indicates a capability to monitor PDCCH candidates for downlink cells, , and downlink cells, and is configured with downlink cells or uplink cells

the UE expects to have respectively received

- at most PDCCHs for DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PDSCH receptions for which the UE has not received any corresponding PDSCH symbol over all serving cells that are provided *monitoringCapabilityConfig* = *r15monitoringcapability*

- at most PDCCHs for DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PUSCH transmissions for which the UE has not transmitted any corresponding PUSCH symbol over all serving cells that are provided *monitoringCapabilityConfig* = *r15monitoringcapability*

- at most PDCCHs for DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PDSCH receptions for which the UE has not received any corresponding PDSCH symbol over all serving cells that are provided *monitoringCapabilityConfig* = *r16monitoringcapability*

- at most PDCCHs for DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PUSCH transmissions for which the UE has not transmitted any corresponding PUSCH symbol over all serving cells that are provided *monitoringCapabilityConfig* = *r16monitoringcapability*

- at most PDCCHs for DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PDSCH receptions for which the UE has not received any corresponding PDSCH symbol over all serving cells with SCS configuration

- at most PDCCHs for DCI formats with CRC scrambled by a C-RNTI, or a CS-RNTI, or a MCS-C-RNTI scheduling PUSCH transmissions for which the UE has not transmitted any corresponding PUSCH symbol over all serving cells with SCS configuration

If a UE

- is configured to monitor a first PDCCH candidate for a DCI format 0\_0 and a DCI format 1\_0 from a CSS set and a second PDCCH candidate for a DCI format 0\_0 and a DCI format 1\_0 from a USS set, where the CSS set and the USS set do not include *searchSpaceLinking*, in a CORESET with index zero on an active DL BWP, and

- the DCI formats 0\_0/1\_0 associated with the first PDCCH candidate and the DCI formats 0\_0/1\_0 associated with the second PDCCH candidate have same size, and

- the UE receives the first PDCCH candidate and the second PDCCH candidate over a same set of CCEs, and

- the first PDCCH candidate and the second PDCCH candidate have identical scrambling, and

- the DCI formats 0\_0/1\_0 for the first PDCCH candidate and the DCI formats 0\_0/1\_0 for the second PDCCH candidate have CRC scrambled by either C-RNTI, or MCS-C-RNTI, or CS-RNTI

the UE decodes only the DCI formats 0\_0/1\_0 associated with the first PDCCH candidate.

If a UE detects a DCI format with inconsistent information, the UE discards all the information in the DCI format.

A UE configured with a bandwidth part indicator in a DCI format determines, in case of an active DL BWP or of an active UL BWP change, that the information in the DCI format is applicable to the new active DL BWP or UL BWP, respectively, as described in clause 12.

For unpaired spectrum operation, if a UE is not configured for PUSCH/PUCCH transmission on serving cell , the UE does not expect to monitor PDCCH on serving cell if the PDCCH overlaps in time with SRS transmission (including any interruption due to uplink or downlink RF retuning time [10, TS 38.133]) on serving cell and if the UE is not capable of simultaneous reception and transmission on serving cell and serving cell .

If a UE is provided *resourceBlocks* and s*ymbolsInResourceBlock* in *RateMatchPattern*, or if the UE is additionally provided *periodicityAndPattern* in *RateMatchPattern*, the UE can determine a set of RBs in symbols of a slot that are not available for PDSCH reception as described in [6, TS 38.214]. If a PDCCH candidate in a slot is mapped to one or more REs that overlap with REs of any RB in the set of RBs in symbols of the slot, the UE does not expect to monitor the PDCCH candidate.

A UE does not expect to be configured with *dci-FormatsSL* and *dci-FormatsExt* in a same USS.

\*\*\* Unchanged text is omitted \*\*\*

## 10.2 PDCCH validation for DL SPS and UL grant Type 2

A UE validates, for scheduling activation or scheduling release, a DL SPS assignment PDCCH or a configured UL grant Type 2 PDCCH if

- the CRC of a corresponding DCI format is scrambled with a CS-RNTI provided by *cs-RNTI*, and

- the new data indicator field in the DCI format for the enabled transport block is set to '0', and

- the DFI flag field, if present, in the DCI format is set to '0', and

- the time domain resource assignment field in the DCI format indicates a row with single SLIV, and

- if validation is for scheduling activation and if the PDSCH-to-HARQ\_feedback timing indicator field in the DCI format is present, the PDSCH-to-HARQ\_feedback timing indicator field does not provide an inapplicable value from *dl-DataToUL-ACK-r16*.

If a UE is provided a single configuration for UL grant Type 2 PUSCH or for SPS PDSCH, validation of the DCI format is achieved if all fields for the DCI format are set according to Table 10.2-1 or Table 10.2-2.

\*\*\* Unchanged text is omitted \*\*\*

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

A UE can be provided a group index for a respective Type3-PDCCH CSS set or USS set by *searchSpaceGroupIdList* for PDCCH monitoring on a serving cell. If the UE is not provided *searchSpaceGroupIdList* for a search space set, the following procedures are not applicable for PDCCH monitoring according to the search space set.

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

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

A UE can be provided by *searchSpaceSwitchDelay* a number of symbols where a minimum value of is provided in Table 10.4-1 for UE processing capability 1 and UE processing capability 2 and SCS configuration . UE processing capability 1 for SCS configuration applies unless the UE indicates support for UE processing capability 2.

Table 10.4-1: Minimum value of [symbols]

|  |  |  |
| --- | --- | --- |
|  | Minimum value for  UE processing capability 1 [symbols] | Minimum value for  UE processing capability 2 [symbols] |
| 0 | 25 | 10 |
| 1 | 25 | 12 |
| 2 | 25 | 22 |
| 3 | 40 | - |
| 5 | 160 | - |
| 6 | 320 | - |

A UE can be provided, by *searchSpaceSwitchTimer*, a timer value for a serving cell that the UE is provided *searchSpaceGroupIdList* or, if provided, for a set of serving cells provided by *cellGroupsForSwitchList*. The UE decrements the timer value by one after each slot based on a reference SCS configuration that is the smallest SCS configuration among all configured DL BWPs in the serving cell, or in the set of serving cells. The UE maintains the reference SCS configuration during the timer decrement procedure.

If a UE is provided by *SearchSpaceSwitchTrigger* a location of a search space set group switching flag field in a DCI format 2\_0, as described in clause 11.1.1, for a serving cell where the UE has active DL BWP with SCS configuration

- if the UE detects a DCI format 2\_0 and a value of the search space set group switching flag field in the DCI format 2\_0 is 0, the UE starts monitoring PDCCH according to search space sets with group index 0, and stops monitoring PDCCH according to search space sets with group index 1, on the serving cell

- at the beginning of the first slot that is at least symbols after the last symbol of the PDCCH with the DCI format 2\_0 when

- at the beginning of the first slot, of a slot group of slots, that is at least symbols after the last symbol of the PDCCH with the DCI format 2\_0 when

- if the UE detects a DCI format 2\_0 and a value of the search space set group switching flag field in the DCI format 2\_0 is 1, the UE starts monitoring PDCCH according to search space sets with group index 1, and stops monitoring PDCCH according to search space sets with group index 0, on the serving cell

- at the beginning of the first slot that is at least symbols after the last symbol of the PDCCH with the DCI format 2\_0 when

- at the beginning of the first slot, of a slot group of slots, that is at least symbols after the last symbol of the PDCCH with the DCI format 2\_0 when

and the UE sets the timer value to the value provided by *searchSpaceSwitchTimer*

- if the UE monitors PDCCH for a serving cell according to search space sets with group index 1, the UE starts monitoring PDCCH on the serving cell according to search space sets with group index 0, and stops monitoring PDCCH according to search space sets with group index 1, for the serving cell

- at the beginning of the first slot that is at least symbols after a slot where the timer expires or after a last symbol of a remaining channel occupancy duration for the serving cell if indicated by DCI format 2\_0 when

- at the beginning of the first slot, of a slot group of slots, that is at least symbols after a slot where the timer expires or after a last symbol of a remaining channel occupancy duration for the serving cell if indicated by DCI format 2\_0 when

If a UE is not provided *SearchSpaceSwitchTrigger* for a serving cell,

- if the UE detects a DCI format by monitoring PDCCH according to a search space set with group index 0, the UE starts monitoring PDCCH according to search space sets with group index 1, and stops monitoring PDCCH according to search space sets with group index 0, for the serving cell

- at the beginning of the first slot that is at least symbols after the last symbol of the PDCCH with the DCI format when ,

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

the UE sets the timer value to the value provided by *searchSpaceSwitchTimer* if the UE detects a DCI format by monitoring PDCCH in any search space set

- if the UE monitors PDCCH for a serving cell according to search space sets with group index 1, the UE starts monitoring PDCCH for the serving cell according to search space sets with group index 0, and stops monitoring PDCCH according to search space sets with group index 1, for the serving cell

- at the beginning of the first slot that is at least symbols after a slot where the timer expires or, if the UE is provided a search space set to monitor PDCCH for detecting a DCI format 2\_0, after a last symbol of a remaining channel occupancy duration for the serving cell if indicated by DCI format 2\_0 when ,

- at the beginning of the first slot, of a slot group of slots, that is at least symbols after a slot where the timer expires or, if the UE is provided a search space set to monitor PDCCH for detecting a DCI format 2\_0, after a last symbol of a remaining channel occupancy duration for the serving cell if indicated by DCI format 2\_0 when

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

A UE can be provided a set of durations by *PDCCHSkippingDurationList* for PDCCH monitoring on a serving cell and, if the UE is not provided *searchSpaceGroupIdList-r17*, a DCI format 0\_1, and/or DCI format 1\_1, and/or DCI format 0\_2, and/or DCI format 1\_2 that schedules a PUSCH transmission or a PDSCH reception can include a PDCCH monitoring adaptation field of 1 bit or of 2 bits.

If the field has 1 bit and for PDCCH monitoring according to Type3-PDCCH CSS sets or USS sets on the serving cell

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

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

If the field has 2 bits and for PDCCH monitoring according to Type3-PDCCH CSS sets or USS sets on a serving cell

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

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

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

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

A UE can be provided group indexes for a Type3-PDCCH CSS set or USS set by *searchSpaceGroupIdList-r17* for PDCCH monitoring on a serving cell and, if the UE is not provided *PDCCHSkippingDurationList*, DCI format 0\_1, or DCI format 1\_1, or DCI format 0\_2, or DCI format 1\_2 that schedules a PUSCH transmission or a PDSCH reception can include a PDCCH monitoring adaptation field of 1 bit or of 2 bits.

If the field has 1 bit and for PDCCH monitoring according to Type3-PDCCH CSS sets or USS sets on the serving cell

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

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

If the field has 2 bits and for PDCCH monitoring according to Type3-PDCCH CSS sets or USS sets on the serving cell

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

- a '01' value for the bit indicates start of PDCCH monitoring according to search space sets with group index 1 and stop of PDCCH monitoring according to search space sets with other group indexes, if any

- a '10' value for the bit indicates start of PDCCH monitoring according to search space sets with group index 2 and stop of PDCCH monitoring according to search space sets with other group indexes, if any

- a '11' value is reserved

A UE can be provided a set of durations by *PDCCHSkippingDurationList* and group indexes for a Type3-PDCCH CSS set or USS set by *searchSpaceGroupIdList-r17* for PDCCH monitoring on a serving cell and, a DCI format 0\_1, and/or DCI format 1\_1, and/or DCI format 0\_2, and/or DCI format 1\_2 that schedules a PUSCH transmission or a PDSCH reception can include a PDCCH monitoring adaptation field of 2 bits.

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

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

- a '01' value for the bit indicates start of PDCCH monitoring according to search space sets with group index 1 and stop of PDCCH monitoring according to search space sets with group index 0, if any

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

- a '11' value is reserved

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

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

- a '01' value for the bit indicates start of PDCCH monitoring according to search space sets with group index 1 and stop of PDCCH monitoring according to search space sets with group index 0, if any

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

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

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

- decrements the timer after a slot of an active DL BWP of the serving cell when the UE does not detect a DCI format in a PDCCH reception in the slot for TBD

- resets the timer after a slot of the active DL BWP of the serving cell when the UE detects a DCI format in a PDCCH reception in the slot for TBD

When the timer expires, the UE monitors PDCCH on the serving cell according to search space sets with group index 0.

\*\*\* Unchanged text is omitted \*\*\*

## 11.1 Slot configuration

\*\*\* Unchanged text is omitted \*\*\*

For operation on a single carrier in unpaired spectrum, if a UE is configured by higher layers to receive a PDCCH, or a PDSCH, or a CSI-RS, or a DL PRS in a set of symbols of a slot, the UE receives the PDCCH, the PDSCH, the CSI-RS, or the DL PRS if the UE does not detect a DCI format that indicates to the UE to transmit a PUSCH, a PUCCH, a PRACH, or a SRS in at least one symbol of the set of symbols of the slot; otherwise, the UE does not receive the PDCCH, or the PDSCH, or the CSI-RS, or the DL PRS in the set of symbols of the slot.

For a UE operation with shared spectrum channel access in FR1, or in FR2-2 when the UE is provided *ChannelAccessMode2-r17* = ‘*enabled*’, if the UE is provided *csi-RS-ValidationWith-DCI*, is not provided *CO-DurationsPerCell*, and is not provided *SlotFormatCombinationsPerCell*, and if the UE is configured by higher layers to receive a CSI-RS in a set of symbols of a slot, the UE cancels the CSI-RS reception in the set of symbols of the slot if the UE does not detect a DCI format indicating an aperiodic CSI-RS reception or scheduling a PDSCH reception in the set of symbols of the slot.

If a UE is provided *channelAccessMode ='dynamic'* and is provided *availableRB-SetsToAddModList* and *availableRB-SetsToReleaseList*, the UE expects to be provided *co-DurationsPerCellToAddModList* and *co-DurationsPerCellToReleaseList* and/or *slotFormatCombToAddModList* and *slotFormatCombToReleaseList*.

\*\*\* Unchanged text is omitted \*\*\*

If a UE is configured by higher layers to receive a CSI-RS or a PDSCH in a set of symbols of a slot and the UE detects a DCI format 2\_0 with a slot format value other than 255 that indicates a slot format with a subset of symbols from the set of symbols as uplink or flexible, or the UE detects a DCI format indicating to the UE to transmit PUSCH, PUCCH, SRS, or PRACH in at least one symbol in the set of the symbols, the UE cancels the CSI-RS reception in the set of symbols of the slot or cancels the PDSCH reception in the slot.

For a UE operation with shared spectrum channel access in FR1, or in FR2-2 when the UE is provided *ChannelAccessMode2-r17* = ‘*enabled*’, if a UE is configured by higher layers to receive a CSI-RS and the UE is provided *CO-DurationsPerCell*, for a set of symbols of a slot that are indicated as downlink or flexible by *tdd-UL-DL-ConfigurationCommon* or *tdd*-*UL-DL-ConfigurationDedicated*, or when *tdd-UL-DL-ConfigurationCommon* and *tdd*-*UL-DL-ConfigurationDedicated* are not provided, the UE cancels the CSI-RS reception in the set of symbols of the slot that are not within the remaining channel occupancy duration.

If a UE is configured by higher layers to receive a DL PRS in a set of symbols of a slot and the UE detects a DCI format 2\_0 with a slot format value other than 255 that indicates a slot format with a subset of symbols from the set of symbols as uplink, or the UE detects a DCI format indicating to the UE to transmit PUSCH, PUCCH, SRS, or PRACH in at least one symbol in the set of the symbols, the UE cancels the DL PRS reception in the set of symbols of the slot.

\*\*\* Unchanged text is omitted \*\*\*

# 13 UE procedure for monitoring Type0-PDCCH CSS sets

If during cell search a UE determines from *MIB* that a CORESET for Type0-PDCCH CSS set is present, as described in clause 4.1, the UE determines a number of consecutive resource blocks and a number of consecutive symbols for the CORESET of the Type0-PDCCH CSS set from *controlResourceSetZero* in *pdcch-ConfigSIB1*, as described in Tables 13-1 through 13-10, for operation without shared spectrum channel access in FR1 and FR2-1, or as described in Tables 13-1A and 13-4A for operation with shared spectrum channel access in FR1, or as described in Table 13-10A for FR2-2, and determines PDCCH monitoring occasions from *searchSpaceZero* in *pdcch-ConfigSIB1*, included in *MIB*, as described in Tables 13-11 through 13-15. and are the SFN and slot index within a frame of the CORESET based on SCS of the CORESET and and are the SFN and slot index based on SCS of the CORESET, respectively, where the SS/PBCH block with index overlaps in time with system frame and slot . The symbols of the CORESET associated with *pdcch-ConfigSIB1* in *MIB* or with *searchSpaceSIB1* in *PDCCH-ConfigCommon* have normal cyclic prefix.

For operation with shared spectrum channel access in FR2-2 and for operation without shared spectrum channel access, a UE assumes that the offset in Tables 13-1 through 13-10A is defined with respect to the SCS of the CORESET for Type0-PDCCH CSS set from the smallest RB index of the CORESET for Type0-PDCCH CSS set to the smallest RB index of the common RB overlapping with the first RB of the corresponding SS/PBCH block. The SCS of the CORESET for Type0-PDCCH CSS set is provided by *subCarrierSpacingCommon* for FR1 and FR2-1 and same as the SCS of the corresponding SS/PBCH block for FR2-2. In Tables 13-7, 13-8, and 13-10, is defined in [4, TS 38.211].

For operation with shared spectrum channel access in FR1, a UE determines an offset from a smallest RB index of the CORESET for Type0-PDCCH CSS set to a smallest RB index of the common RB overlapping with a first RB of the corresponding SS/PBCH block

- according to the offset in Table 13-1A or Table 13-4A, if the frequency position of the SS/PBCH block corresponds to the GSCN of a synchronization raster entry as defined in [8-1, TS 38.101-1], and

- according to a sum of a first offset and a second offset if the frequency position of the SS/PBCH block is provided by *ssbFrequency* in a measurement configuration associated with a reporting configuration providing *reportCGI* and does not correspond to the GSCN of a synchronization raster entry as defined in [8-1, TS 38.101-1], where

- the first offset is provided in Table 13-1A or Table 13-4A, and

- the second offset is determined as the offset from a smallest RB index of the common RB overlapping with the first RB of the SS/PBCH block indicated in the measurement configuration to a smallest RB index of the common RB overlapping with the first RB of a SS/PBCH block hypothetically located at the GSCN of a synchronization raster entry, where the single synchronization raster entry is located in the same channel as the SS/PBCH block used for the shared spectrum channel access procedure, as described in [15, TS 37.213]

where the offsets are defined with respect to the SCS of the CORESET for Type0-PDCCH CSS set that is same as the SCS of the corresponding SS/PBCH block.

For operation without shared spectrum channel access and for the SS/PBCH block and CORESET multiplexing pattern 1, a UE monitors PDCCH in the Type0-PDCCH CSS set over two slots. For SS/PBCH block with index , the UE determines an index of slot as that is in a frame with system frame number (SFN) satisfying if , or in a frame with SFN satisfying if where based on the SCS for PDCCH receptions in the CORESET [4, TS 38.211].

- For and for a SS/PBCH block index , the two slots including the associated Type0-PDCCH monitoring occasions are slots and . , , and the index of the first symbol of the CORESET in slots and are provided by Table 13-11 and Table 13-12.

- For and for a SS/PBCH block index , the two slots including the associated Type0-PDCCH monitoring occasions are slots and . , , and the index of the first symbol of the CORESET in slots and are provided by Table 13-12A, where .

- For and for a SS/PBCH block index , the two slots including the associated Type0-PDCCH monitoring occasions are slots and . , , and the index of the first symbol of the CORESET in slots and are provided by Table 13-12A, where .

\*\*\* Unchanged text is omitted \*\*\*

Table 13-10A: Set of resource blocks and slot symbols of CORESET for Type0-PDCCH search space set when {SS/PBCH block, PDCCH} SCS is {120, 120} kHz, {480, 480} kHz, or {960, 960} kHz for FR2-2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Index | SS/PBCH block and CORESET multiplexing pattern | Number of RBs | Number of Symbols | Offset (RBs) |
| 0 | 1 | 24 | 2 | 0 |
| 1 | 1 | 24 | 2 | 4 |
| 2 | 1 | 48 | 1 | 0 |
| 3 | 1 | 48 | 1 | 14 |
| 4 | 1 | 48 | 1 | 28 |
| 5 | 1 | 48 | 2 | 0 |
| 6 | 1 | 48 | 2 | 14 |
| 7 | 1 | 48 | 2 | 28 |
| 8 | 1 | 96 | 1 | 0 |
| 9 |  |  |  |  |
| 10 | 1 | 96 | 2 | 0 |
| 11 |  |  |  |  |
| 12 | 3 | 24 | 2 | -20 if  -21 if |
| 13 | 3 | 24 | 2 | -24 |
| 14 | 3 | 48 | 2 | -20 if  -21 if |
| 15 | 3 | 48 | 2 | -48 |







\*\*\* Unchanged text is omitted \*\*\*

Table 13-15A: PDCCH monitoring occasions for Type0-PDCCH CSS set - SS/PBCH block and CORESET multiplexing pattern 3 and {SS/PBCH block, PDCCH} SCS {480, 480} kHz or {960, 960} kHz

|  |  |  |
| --- | --- | --- |
| Index | PDCCH monitoring occasions (SFN and slot number) | **First symbol index**  **(*k* = 0, 1, … 31)** |
| 0 |  | 2, 9 in  , |
| 1 | Reserved | |
| 2 | Reserved | |
| 3 | Reserved | |
| 4 | Reserved | |
| 5 | Reserved | |
| 6 | Reserved | |
| 7 | Reserved | |
| 8 | Reserved | |
| 9 | Reserved | |
| 10 | Reserved | |
| 11 | Reserved | |
| 12 | Reserved | |
| 13 | Reserved | |
| 14 | Reserved | |
| 15 | Reserved | |

If a UE detects a first SS/PBCH block and determines that a CORESET for Type0-PDCCH CSS set is not present, and for for FR1 or for for FR2, the UE may determine the nearest (in the corresponding frequency direction) global synchronization channel number (GSCN) of a second SS/PBCH block having a CORESET for an associated Type0-PDCCH CSS set as . is the GSCN of the first SS/PBCH block and is a GSCN offset provided by Table 13-16 for FR1 and Table 13-17 for FR2. If the UE detects the second SS/PBCH block and the second SS/PBCH block does not provide a CORESET for Type0-PDCCH CSS set, as described in clause 4.1, the UE may ignore the information related to GSCN of SS/PBCH block locations for performing cell search.

If a UE detects a SS/PBCH block and determines that a CORESET for Type0-PDCCH CSS set is not present, and for for FR1 or for for FR2, the UE determines that there is no SS/PBCH block having an associated Type0-PDCCH CSS set within a GSCN range . and are respectively determined by *controlResourceSetZero* and *searchSpaceZero* in *pdcch-ConfigSIB1*. If the GSCN range is , the UE determines that there is no information for a second SS/PBCH block with a CORESET for an associated Type0-PDCCH CSS set on the detected SS/PBCH block.

If a UE does not detect any SS/PBCH block providing a CORESET for Type0-PDCCH CSS set, as described in clause 4.1, within a time period determined by the UE, the UE may ignore the information related to GSCN of SS/PBCH locations in performing cell search.

Table 13-16: Mapping between the combination of and *controlResourceSetZero* and *searchSpaceZero* in *pdcch-ConfigSIB1* to for FR1

|  |  |  |
| --- | --- | --- |
|  | *16×controlResourceSetZero +searchSpaceZero* |  |
| 24 | 0, 1, …, 255 | 1, 2, …, 256 |
| 25 | 0, 1, …, 255 | 257, 258, …, 512 |
| 26 | 0, 1, …, 255 | 513, 514, …., 768 |
| 27 | 0, 1, …, 255 | -1, -2, …, -256 |
| 28 | 0, 1, …, 255 | -257, -258, …, -512 |
| 29 | 0, 1, …, 255 | -513, -514, …., -768 |
| 30 | 0, 1, …, 255 | Reserved, Reserved, …, Reserved |

Table 13-17: Mapping between the combination of and *controlResourceSetZero* and *searchSpaceZero* in *pdcch-ConfigSIB1* to for FR2

|  |  |  |
| --- | --- | --- |
|  | *16×controlResourceSetZero +searchSpaceZero* |  |
| 12 | 0, 1, …, 255 | 1, 2, …, 256 |
| 13 | 0, 1, …, 255 | -1, -2, …, -256 |
| 14 | 0, 1, …, 255 | Reserved, Reserved, …, Reserved |