**3GPP TSG-RAN WG1 Meeting #105-eR1-21xxxxx**

**e-Meeting, May 19-27, 2021**

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| *CR-Form-v12.0* |
| **CHANGE REQUEST** |
|  |
|  | **36.212** | **CR** | **DRAFT** | **rev** |  | **Current version:** | **15.13.0** |  |
|  |
| *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:***  | Alignment of EN-DC/NE-DC parameter names |
|  |  |
| ***Source to WG:*** | FUTUREWEI |
| ***Source to TSG:*** |  |
|  |  |
| ***Work item code:*** | NR\_newRAT-Core |  | ***Date:*** | 2021-05-27 |
|  |  |  |  |  |
| ***Category:*** | F |  | ***Release:*** | Rel-15 |
|  | *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 canbe 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:*** | Alignment of EN-DC/NE-DC parameter names |
|  |  |
| ***Summary of change:*** | Replace the parameter *subframeAssignment-r15* with the parameters *tdm-PatternConfig/tdm-PatternConfigNE-DC* throughout the specification |
|  |  |
| ***Consequences if not approved:*** | Confusion on which parameters to use  |
|  |  |
| ***Clauses affected:*** | 5.2.2.6, 5.2.3.1, 5.3.3.1.1, 5.3.3.1.1C, 5.3.3.1.2, 5.3.3.1.3, 5.3.3.1.3A, 5.3.3.1.4A, 5.3.3.1.5, 5.3.3.1.5A, 5.3.3.1.5B, 5.3.3.1.5C, 5.3.3.1.5D, 5.3.3.1.8 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  |  Other core specifications  | TS 36.213 |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

#### 5.2.2.6 Channel coding of control information

\*\* unchanged parts skipped \*\*

For FDD when the UE is not configured with EN-DC/NE-DC and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC*, when HARQ ACK consists of 2 or more bits of information as a result of the aggregation of more than one DL cell, the bit sequence  corresponding to PDSCH with subframe duration is the result of the concatenation of HARQ-ACK bits for the multiple DL cells according to the following pseudo-code:

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

Set *j* = 0 – HARQ-ACK bit index

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

while *c* < 

if transmission mode configured in cell  – 1 bit HARQ-ACK feedback for this cell

 HARQ-ACK bit of this cell

*j* = *j* + 1

else

if the PUSCH is with subframe or slot duration and the UE is not configured with spatial bundling on PUSCH by higher layers

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

*j* = *j* + 1

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

*j* = *j* + 1

else

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

*j* = *j* + 1

end if

end if

*c* = *c* + 1

end while

For the aggregation of more than one DL cell including a primary cell using FDD and at least one secondary cell using TDD when the UE is not configured with EN-DC/NE-DC and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC*, the bit sequence  is the result of the concatenation of HARQ-ACK bits for one or multiple DL cells. Define  as the number of cells configured by higher layers for the UE and  as the number of subframes for which the UE needs to feed back HARQ-ACK bits in UL subframe n for the *c*-th serving cell. For a cell using TDD, the subframes are determined by the DL-reference UL/DL configuration if the UE is configured with higher layer parameter *eimta-HARQ-ReferenceConfig*, and determined by the UL/DL configuration otherwise. For a cell using TDD,  if subframe n-4 in the cell, or subframe n-3 in the cell if higher layer parameter *shortProcessingTime* is configured for the cell, is a DL subframe or a special subframe with special subframe configurations 1/2/3/4/6/7/8/9/10 and normal downlink CP or a special subframe with special subframe configurations 1/2/3/5/6/7 and extended downlink CP, and  otherwise. For a cell using FDD, .

The bit sequence  is performed according to the following pseudo-code:

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

Set *j* = 0 – HARQ-ACK bit index

while *c* < 

if 

if transmission mode configured in cell  – 1 bit HARQ-ACK feedback for this cell

 HARQ-ACK bit of this cell

*j* = *j* + 1

else

if the PUSCH is with subframe or slot duration and the UE is not configured with spatial bundling on PUSCH by higher layers

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

*j* = *j* + 1

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

*j* = *j* + 1

else

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

*j* = *j* + 1

end if

end if

end if

*c* = *c* + 1

end while

For the cases with TDD primary cell or EN-DC/NE-DC with FDD primary cell and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC* configured, when HARQ-ACK is for the aggregation of one or more DL cells and the UE is configured with PUCCH format 3, PUCCH format 4 or PUCCH format 5 [3], the bit sequence  is the result of the concatenation of HARQ-ACK bits for the one or more DL cells configured by higher layers and the multiple subframes as defined in [3].

Define  as the number of cells configured by higher layers for the UE and  as the number of subframes for which the UE needs to feed back HARQ-ACK bits as defined in Clause 7.3 of [3].

The number of HARQ-ACK bits for the UE to convey if it is configured with PUCCH format 3, PUCCH format 4 or PUCCH format 5 is computed as follows:

Set *k* = 0 – counter of HARQ-ACK bits

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

while c < 

set *l* = 0;

while *l* < 

if transmission mode configured in cell  -- 1 bit HARQ-ACK feedback for this cell

*k* = *k* + 1

else

*k* = *k* + 2

end if

*l* = *l*+1

end while

*c* = *c* + 1

end while

When PUCCH format 3 is configured, if *k* ≤ 20 when TDD is used in all the configured serving cell(s) of the UE, or if *k* ≤ 21 when FDD is used in at least one of the configured serving cells with TDD primary cell, or if *k* ≤ 21 when the UE is configured with EN-DC/NE-DC with FDD primary cell and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC*; or when PUCCH format 4 or PUCCH format 5 is configured and when the UE is not configured with spatial bundling on PUSCH by higher layers, the multiplexing of HARQ-ACK bits is performed according to the following pseudo-code:

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

Set *j* = 0 – HARQ-ACK bit index

while c < 

set *l* = 0;

while *l* < 

if transmission mode configured in cell  -- 1 bit HARQ-ACK feedback for this cell

 HARQ-ACK bit of this cell as defined in Clause 7.3 of [3]

*j* = *j* + 1

else

 HARQ-ACK bits of this cell as defined in Clause 7.3 of [3]

*j* = *j* + 2

end if

*l* = *l*+1

end while

*c* = *c* + 1

end while

When PUCCH format 3 is configured, if *k* > 20 when TDD is used in all the configured serving cell(s) of the UE, or if *k* > 21 when FDD is used in at least one of the configured serving cells with TDD primary cell, or if *k* > 21 when the UE is configured with EN-DC/NE-DC with FDD primary cell and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC*, spatial bundling is applied to all subframes in all cells; or when PUCCH format 4 or PUCCH format 5 is configured and when the UE is configured with spatial bundling on PUSCH by higher layers; or when the PUSCH is subslot duration, the multiplexing of HARQ-ACK bits is performed according to the following pseudo-code:

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

Set *j* = 0 – HARQ-ACK bit index

while c < 

set *l* = 0;

while *l* < 

if transmission mode configured in cell  – 1 bit HARQ-ACK feedback for this cell

HARQ-ACK bit of this cell as defined in Clause 7.3 of [3]

*j* = *j* + 1

else

 binary AND operation of the HARQ-ACK bits corresponding to the first and second codewords of this cell as defined in Clause 7.3 of [3]

*j* = *j* + 1

end if

*l* = *l*+1

end while

*c* = *c* + 1

end while

For FDD with at least one cell configured with higher layer parameter *dl-STTI-Length* or for the aggregation of more than one DL cell including a primary cell using FDD and at least one secondary cell using TDD and at least one DL cell configured with higher layer parameter *dl-STTI-Length,* bit sequence is obtained by concatenation of the bit sequence  and , where  in the cases defined in clause 7.3 of [3]. In all other cases, the sequence of bits  is given by. For the cases with TDD primary cell with at least one cell configured with higher layer parameter *dl-STTI-Length*, the bit sequence  is as defined in [3].

For  or , the bit sequence  is obtained by setting .

For , the bit sequence  is obtained by setting  if *i* is even and  if *i* is odd.

For the cases with TDD primary cell when HARQ-ACK is for the aggregation of two DL cells and the UE is configured with PUCCH format 1b with channel selection, the bit sequence is obtained as described in clause 7.3 of [3].

For TDD HARQ-ACK bundling, a bit sequence  is obtained by concatenation of multiple encoded HARQ-ACK blocks where  is the total number of coded bits for all the encoded HARQ-ACK blocks. The last concatenation of the encoded HARQ-ACK block may be partial so that the total bit sequence length is equal to. A scrambling sequence  is then selected from Table 5.2.2.6-A with index , where  is determined as described in clause 7.3 of [3]. The bit sequence  is then generated by setting  if HARQ-ACK consists of 1-bit and  if HARQ-ACK consists of 2-bits and then scrambling  as follows

Set *i, k* to 0

while 

if  // place-holder repetition bit





else

if  // a place-holder bit



else // coded bit





end if



end while

Table 5.2.2.6-A: Scrambling sequence selection for TDD HARQ-ACK bundling

|  |  |
| --- | --- |
|  |  |
| 0 | [1 1 1 1] |
| 1 | [1 0 1 0] |
| 2 | [1 1 0 0] |
| 3 | [1 0 0 1] |

When HARQ-ACK information is to be multiplexed with UL-SCH at a given PUSCH, the HARQ-ACK information is multiplexed in all layers of all transport blocks of that PUSCH, For a given transport block, the vector sequence output of the channel coding for HARQ-ACK information is denoted by , where ,  are column vectors of length  and where  is obtained as follows:

Set *i, k* to 0

while 

 -- temporary row vector

 -- replicating the row vector *NL* times and transposing into a column vector





end while

where  is the number of layers onto which the UL-SCH transport block is mapped.

For rank indication (RI) (RI only, joint report of RI and i1, joint report of CRI and RI, joint report of CRI, RI and i1, joint report of CRI, RI, and PTI, joint report of RI and i1,p-2, and joint report of RI and PTI) or CRI

- The corresponding bit widths for CRI feedback for PDSCH transmissions are given by Tables 5.2.2.6.1-2A, 5.2.2.6.1-2C, 5.2.2.6.1-2G, 5.2.2.6.2-3A, 5.2.2.6.2-3C, 5.2.2.6.2-3G, 5.2.2.6.3-3A, 5.2.2.6.3-3C, 5.2.2.6.3-3G, 5.2.3.3.1-3E, 5.2.3.3.1-3H, 5.2.3.3.2-4E, and 5.2.3.3.2-4H.

- The corresponding bit widths for RI feedback for PDSCH transmissions are given by Tables 5.2.2.6.1-2, 5.2.2.6.1-2B, 5.2.2.6.1-2D, 5.2.2.6.1-2E, 5.2.2.6.1-2F, 5.2.2.6.2-3, 5.2.2.6.2-3B, 5.2.2.6.2-3D, 5.2.2.6.2-3E, 5.2.2.6.2-3F, 5.2.2.6.3-3, 5.2.2.6.3-3B, 5.2.2.6.3-3D, 5.2.2.6.3-3E, 5.2.2.6.3-3F, 5.2.3.3.1-3, 5.2.3.3.1-3A, 5.2.3.3.1-3B, 5.2.3.3.1-3B-1, 5.2.3.3.1-3C, 5.2.3.3.1-3D, 5.2.3.3.1-3F, 5.2.3.3.1-3G, 5.2.3.3.1-3I, 5.2.3.3.1-3J, 5.2.3.3.1-5, 5.2.3.3.2-4, 5.2.3.3.2-4A, 5.2.3.3.2-4B, 5.2.3.3.2-4C, 5.2.3.3.2-4D, 5.2.3.3.2-4F, 5.2.3.3.2-4G and 5.2.3.3.2-4I which are determined assuming the maximum number of layers as follows:

- If the *maxLayersMIMO-r10* is configured for the DL cell, the maximum number of layers for subframe operation is determined according to *maxLayersMIMO-r10* for the DL cell.

- If the UE is configured with *ShortTTI* and if the higher layer parameter *maxLayersMIMO-sTTI-r15* is configured for the DL cell, the maximum number of layers for slot/subslot operation is determined according to *maxLayersMIMO-sTTI-r15* for the DL cell.

- Else,

- If the UE is configured with transmission mode 9, and the *supportedMIMO-CapabilityDL-r10* field is included in the *UE-EUTRA-Capability*, the maximum number of layers is determined according to the minimum of the configured number of CSI-RS ports and the maximum of the reported UE downlink MIMO capabilities for the same band in the corresponding band combination.

- If the UE is configured with transmission mode 9, and higher layer parameter *eMIMO-Type*, and *eMIMO-Type* is set to 'CLASS B' with K>1, and RI and CRI are transmitted in the same reporting instance, and the *supportedMIMO-CapabilityDL-r10* field is included in the *UE-EUTRA-Capability*, the maximum number of layers is determined according to the minimum of the maximum of number of antenna port of the configured CSI-RS resources and the maximum of the reported UE downlink MIMO capabilities for the same band in the corresponding band combination.

- If the UE is configured with transmission mode 9, and the *supportedMIMO-CapabilityDL-r10* field is not included in the *UE-EUTRA-Capability*, the maximum number of layers is determined according to the minimum of the configured number of CSI-RS ports and *ue-Category* (without suffix).

- If the UE is configured with transmission mode 9, and higher layer parameter *eMIMO-Type*, and *eMIMO-Type* is set to 'CLASS B' with K>1, and RI and CRI are transmitted in the same reporting instance, and the *supportedMIMO-CapabilityDL-r10* field is not included in the *UE-EUTRA-Capability*, the maximum number of layers is determined according to the minimum of the maximum of number of antenna port of the configured CSI-RS resources and *ue-Category* (without suffix).

- If the UE is configured with transmission mode 9, and higher layer parameter *semiOpenLoop*, and the *supportedMIMO-CapabilityDL-r10* field is included in the *UE-EUTRA-Capability*, the maximum number of layers is determined according to the minimum of 2 and the maximum of the reported UE downlink MIMO capabilities for the same band in the corresponding band combination.

- If the UE is configured with transmission mode 9, and higher layer parameter *semiOpenLoop*, and the *supportedMIMO-CapabilityDL-r10* field is not included in the *UE-EUTRA-Capability*, the maximum number of layers is determined according to the minimum of 2 and *ue-Category* (without suffix).

 - If the UE is configured with transmission mode 9, and higher layer parameter *eMIMO-Type*, and *eMIMO-Type* is set to 'CLASS B' with K>1 with *activatedResources*>1, and RI and CRI are transmitted in the same reporting instance, and the *supportedMIMO-CapabilityDL-r10* field is included in the *UE-EUTRA-Capability*, the maximum number of layers is determined according to the minimum of the maximum of number of antenna ports of the activated CSI-RS resources and the maximum of the reported UE downlink MIMO capabilities for the same band in the corresponding band combination.

- If the UE is configured with transmission mode 9, and higher layer parameter *eMIMO-Type*, and *eMIMO-Type* is set to 'CLASS B' with K>1 with *activatedResources*>1, and RI and CRI are transmitted in the same reporting instance, and the *supportedMIMO-CapabilityDL-r10* field is not included in the *UE-EUTRA-Capability*, the maximum number of layers is determined according to the minimum of the maximum of number of antenna ports of the activated CSI-RS resources and *ue-Category* (without suffix).

- If the UE is configured with transmission mode 9, and higher layer parameter *eMIMO-Type*, and *eMIMO-Type* is set to 'CLASS B' with *activatedResources*=1 or *numberActivatedAperiodicCSI-RS-Resources*>0, and the *supportedMIMO-CapabilityDL-r10* field is included in the *UE-EUTRA-Capability*, the maximum number of layers is determined according to the minimum of the number of antenna port of the activated or selected CSI-RS resource and the maximum of the reported UE downlink MIMO capabilities for the same band in the corresponding band combination.

- If the UE is configured with transmission mode 9, and higher layer parameter *eMIMO-Type*, and *eMIMO-Type* is set to 'CLASS B' with *activatedResources*=1 or *numberActivatedAperiodicCSI-RS-Resources*>0, and the *supportedMIMO-CapabilityDL-r10* field is not included in the *UE-EUTRA-Capability*, the maximum number of layers is determined according to the minimum of the number of antenna ports of the activated or selected CSI-RS resource and *ue-Category* (without suffix).

- If the UE is configured with transmission mode 9 and higher layer parameter *eMIMO-Type* and *eMIMO-Type2*, and the *supportedMIMO-CapabilityDL-r10* field is included in the *UE-EUTRA-Capability*, the maximum number of layers is determined according to the minimum of the configured number of CSI-RS ports of *eMIMO-Type2* and the maximum of the reported UE downlink MIMO capabilities for the same band in the corresponding band combination.

- If the UE is configured with transmission mode 9 and higher layer parameter *eMIMO-Type* and *eMIMO-Type2*, and the *supportedMIMO-CapabilityDL-r10* field is not included in the *UE-EUTRA-Capability*, the maximum number of layers is determined according to the minimum of the configured number of CSI-RS ports of *eMIMO-Type2* and *ue-Category* (without suffix).

- If the UE is configured with transmission mode 10, and the *supportedMIMO-CapabilityDL-r10* field is included in the *UE-EUTRA-Capability*, the maximum number of layers for each CSI process is determined according to the minimum of the configured number of CSI-RS ports for that CSI process and the maximum of the reported UE downlink MIMO capabilities for the same band in the corresponding band combination.

- If the UE is configured with transmission mode 10, and higher layer parameter *eMIMO-Type*, and *eMIMO-Type* is set to 'CLASS B' with K>1, and RI and CRI are transmitted in the same reporting instance, and the *supportedMIMO-CapabilityDL-r10* field is included in the *UE-EUTRA-Capability*, the maximum number of layers for each CSI process is determined according to the minimum of the maximum of number of antenna port of the configured CSI-RS resources in that CSI process and the maximum of the reported UE downlink MIMO capabilities for the same band in the corresponding band combination.

- If the UE is configured with transmission mode 10, and the *supportedMIMO-CapabilityDL-r10* field is not included in the *UE-EUTRA-Capability*, the maximum number of layers for each CSI process is determined according to the minimum of the configured number of CSI-RS ports for that CSI process and *ue-Category* (without suffix).

- If the UE is configured with transmission mode 10, and higher layer parameter *eMIMO-Type*, and *eMIMO-Type* is set to 'CLASS B' with K>1, and RI and CRI are transmitted in the same reporting instance, and the *supportedMIMO-CapabilityDL-r10* field is not included in the *UE-EUTRA-Capability*, the maximum number of layers for each CSI process is determined according to the minimum of the maximum of number of antenna port of the configured CSI-RS resources in that CSI process and *ue-Category* (without suffix).

- If the UE is configured with transmission mode 10, and higher layer parameter *semiOpenLoop*, and the *supportedMIMO-CapabilityDL-r10* field is included in the *UE-EUTRA-Capability*, the maximum number of layers for each CSI process is determined according to the minimum of 2 and the maximum of the reported UE downlink MIMO capabilities for the same band in the corresponding band combination.

- If the UE is configured with transmission mode 10, and higher layer parameter *semiOpenLoop*, and the *supportedMIMO-CapabilityDL-r10* field is not included in the *UE-EUTRA-Capability*, the maximum number of layers for each CSI process is determined according to the minimum of 2 and *ue-Category* (without suffix).

- If the UE is configured with transmission mode 10, and higher layer parameter *eMIMO-Type*, and *eMIMO-Type* is set to 'CLASS B' with K>1 with *activatedResources*>1, and RI and CRI are transmitted in the same reporting instance, and the *supportedMIMO-CapabilityDL-r10* field is included in the *UE-EUTRA-Capability*, the maximum number of layers for each CSI process is determined according to the minimum of the maximum of number of antenna ports of the activated CSI-RS resources in that CSI process and the maximum of the reported UE downlink MIMO capabilities for the same band in the corresponding band combination.

- If the UE is configured with transmission mode 10, and higher layer parameter *eMIMO-Type*, and *eMIMO-Type* is set to 'CLASS B' with K>1 with *activatedResources*>1, and RI and CRI are transmitted in the same reporting instance, and the *supportedMIMO-CapabilityDL-r10* field is not included in the *UE-EUTRA-Capability*, the maximum number of layers for each CSI process is determined according to the minimum of the maximum of number of antenna port of the activated CSI-RS resources in that CSI process and *ue-Category* (without suffix).

- If the UE is configured with transmission mode 10, and higher layer parameter *eMIMO-Type*, and *eMIMO-Type* is set to 'CLASS B' with *activatedResources*=1 or *numberActivatedAperiodicCSI-RS-Resources*>0, and the *supportedMIMO-CapabilityDL-r10* field is included in the *UE-EUTRA-Capability*, the maximum number of layers for each CSI process is determined according to the minimum of the number of antenna ports of the activated or selected CSI-RS resource in that CSI process and the maximum of the reported UE downlink MIMO capabilities for the same band in the corresponding band combination.

- If the UE is configured with transmission mode 10, and higher layer parameter *eMIMO-Type*, and *eMIMO-Type* is set to 'CLASS B' with *activatedResources*=1 or *numberActivatedAperiodicCSI-RS-Resources*>0, and the *supportedMIMO-CapabilityDL-r10* field is not included in the *UE-EUTRA-Capability*, the maximum number of layers for each CSI process is determined according to the minimum of the number of antenna port of the activated or selected CSI-RS resource in that CSI process and *ue-Category* (without suffix).

- If the UE is configured with transmission mode 10 and higher layer parameter *eMIMO-Type* and *eMIMO-Type2*, and the *supportedMIMO-CapabilityDL-r10* field is included in the *UE-EUTRA-Capability*, the maximum number of layers for each CSI process is determined according to the minimum of the configured number of CSI-RS ports of *eMIMO-Type2* for that CSI process and the maximum of the reported UE downlink MIMO capabilities for the same band in the corresponding band combination.

- If the UE is configured with transmission mode 10 and higher layer parameter *eMIMO-Type* and *eMIMO-Type2*, and the *supportedMIMO-CapabilityDL-r10* field is not included in the *UE-EUTRA-Capability*, the maximum number of layers for each CSI process is determined according to the minimum of the configured number of CSI-RS ports of *eMIMO-Type2* for that CSI process and *ue-Category* (without suffix)

- Otherwise the maximum number of layers is determined according to the minimum of the number of PBCH antenna ports and *ue-Category* (without suffix).

- If RI feedback consists of 1-bit of information, i.e., , it is first encoded according to Table 5.2.2.6-3. The  to RI mapping is given by Table 5.2.2.6-5.

- If RI feedback consists of 2-bits of information, i.e.,  with  corresponding to MSB of 2-bit input and  corresponding to LSB, it is first encoded according to Table 5.2.2.6-4 where . The  to RI mapping is given by Table 5.2.2.6-6A if the UE is configured with higher layer parameter *feCoMP-CSI-Enabled*, otherwise given by Table 5.2.2.6-6.

Table 5.2.2.6-3: Encoding of 1-bit RI

|  |  |
| --- | --- |
| *Qm* | Encoded RI |
| 2 |  |
| 4 |  |
| 6 |  |
| 8 |  |

Table 5.2.2.6-4: Encoding of 2-bit RI

|  |  |
| --- | --- |
| *Qm* | Encoded RI |
| 2 |  |
| 4 |  |
| 6 |  |
| 8 |  |

Table 5.2.2.6-5:  to RI mapping

|  |  |
| --- | --- |
|  | RI |
| 0 | 1 |
| 1 | 2 |

Table 5.2.2.6-6: , to RI mapping

|  |  |
| --- | --- |
| ,  | RI |
| 0, 0 | 1 |
| 0, 1 | 2 |
| 1, 0 | 3 |
| 1, 1 | 4 |

Table 5.2.2.6-6A: , to RI mapping

|  |  |  |
| --- | --- | --- |
| ,  | RI (CRI = 0 or 1) | {RI0, RI1} (CRI = 2) |
| 0, 0 | 1 | {1,1} |
| 0, 1 | 2 | {1,2} |
| 1, 0 | 3 | {2,1} |
| 1, 1 | 4 | {2,2} |

Table 5.2.2.6-7: , , to RI mapping

|  |  |
| --- | --- |
| , ,  | RI |
| 0, 0, 0 | 1 |
| 0, 0, 1 | 2 |
| 0, 1, 0 | 3 |
| 0, 1, 1 | 4 |
| 1, 0, 0 | 5 |
| 1, 0, 1 | 6 |
| 1, 1, 0 | 7 |
| 1, 1, 1 | 8 |

Table 5.2.2.6-8: , , ,to RI mapping

|  |  |  |
| --- | --- | --- |
| , , , | RI (CRI = 0 or 1) | {RI0, RI1} (CRI = 2) |
| 0, 0, 0, 0 | 1 | {1,1} |
| 0, 0, 0, 1 | 2 | {1,2} |
| 0, 0, 1, 0 | 3 | {2,1} |
| 0, 0, 1, 1 | 4 | {2,2} |
| 0, 1, 0, 0 | 5 | {2,3} |
| 0, 1, 0, 1 | 6 | {3,2} |
| 0, 1, 1, 0 | 7 | {3,3} |
| 0, 1, 1, 1 | 8 | {3,4} |
| 1, 0, 0, 0 | reserved | {4,3} |
| 1, 0, 0, 1 | reserved | {4,4} |
| 1, 0, 1, 0 | reserved | reserved |
| 1, 0, 1, 1 | reserved | reserved |
| 1, 1, 0, 0 | reserved | reserved |
| 1, 1, 0, 1 | reserved | reserved |
| 1, 1, 1, 0 | reserved | reserved |
| 1, 1, 1, 1 | reserved | reserved |

- If RI feedback for a given DL cell consists of 3-bits of information, i.e.,  with  corresponding to MSB of 3-bit input and  corresponding to LSB. The  to RI mapping is given by Table 5.2.2.6-7.

- If RI feedback for a given DL cell consists of 4-bits of information when the UE is configured with higher layer parameter *feCoMP-CSI-Enabled*, i.e.,  with  corresponding to MSB of 4-bit input and  corresponding to LSB, the  to RI mapping is given by Table 5.2.2.6-8.

- If RI feedback consists of  bits of information, i.e., , then a coded bit sequence  is obtained by using the bit sequence  as the input to the channel coding block described in clause 5.2.2.6.4.

- If RI feedback consists of  bits of information as a result of the aggregation of RI bits corresponding to multiple DL cells or multiple CSI processes, i.e., , then the coded bit sequence  is obtained by using the bit sequence  as the input to the channel coding block described in clause 5.2.2.6.5.

- If RI feedback consists of  bits of information as a result of the aggregation of RI bits corresponding to multiple DL cells or multiple CSI processes, i.e., , then the coded bit sequence is denoted by . The CRC attachment, channel coding and rate matching of the HARQ-ACK bits are performed according to clauses 5.1.1 setting *L* to 8 bits, 5.1.3.1 and 5.1.4.2, respectively. The input bit sequence to the CRC attachment operation is . The output bit sequence of the CRC attachment operation is the input bit sequence to the channel coding operation. The output bit sequence of the channel coding operation is the input bit sequence to the rate matching operation.

- A UE capable of supporting only up to 5 serving cells is not expected to support CRI/RI payload larger than 22 bits.

The "x" and "y" in Table 5.2.2.6-3 and 5.2.2.6-4 are placeholders for [2] to scramble the RI bits in a way that maximizes the Euclidean distance of the modulation symbols carrying rank information.

For the case where RI feedback for more than one DL cell is to be reported, the RI report for each DL cell is concatenated prior to coding in increasing order of cell index.

For the case where RI feedback for more than one CSI process is to be reported, the RI reports are concatenated prior to coding first in increasing order of CSI process index for each DL cell and then in increasing order of cell index.

For the case where RI feedback consists of one or two bits of information the bit sequence  is obtained by concatenation of multiple encoded RI blocks where  is the total number of coded bits for all the encoded RI blocks. The last concatenation of the encoded RI block may be partial so that the total bit sequence length is equal to.

For the case where RI feedback consists of bits of information, the bit sequence  is obtained by the circular repetition of the bit sequence  so that the total bit sequence length is equal to.

For the case where CRI feedback is to be reported, the same procedures for RI are applied for CRI. When rank information is to be multiplexed with UL-SCH at a given PUSCH, the rank information is multiplexed in all layers of all transport blocks of that PUSCH. For a given transport block, the vector sequence output of the channel coding for rank information is denoted by , where ,  are column vectors of length  and where . The vector sequence is obtained as follows:

Set *i*, *j*, *k* to 0

while 

 -- temporary row vector

 -- replicating the row vector *NL* times and transposing into a column vector





end while

where  is the number of layers onto which the UL-SCH transport block is mapped.

The same processing procedures for RI and RI multiplexing with UL-SCH at a given PUSCH are applied for CRI, using CRI instead of RI in the equations.

For channel quality control information (CQI and/or PMI denoted as CQI/PMI);

When the UE transmits channel quality control information bits, it shall determine the number of modulation coded symbols per layer  for channel quality information as



where

-  is the number of CQI/PMI bits, and

-  is the number of CRC bits given by , and

- and , where  shall be determined according to [3] depending on the number of transmission codewords for the corresponding PUSCH, the duration of the corresponding PUSCH, and on the uplink power control subframe set for the corresponding PUSCH when two uplink power control subframe sets are configured by higher layers for the cell.

- If neither RI nor CRI is not transmitted then .

The variable "*x*" in  represents the transport block index corresponding to the highest *IMCS* value indicated by the initial UL grant. In case the two transport blocks have the same *IMCS* value in the corresponding initial UL grant, "*x* =1", which corresponds to the first transport block. , , and  are obtained from the initial PDCCH or EPDCCH or MPDCCH or SPDCCH for the same transport block. If there is no initial PDCCH or EPDCCH with DCI format 0/0A/0B/4A/4B or MPDCCH with DCI format 6-0A/6-0B or SPDCCH with DCI format 7-0A/7-0B for the same transport block, , , and  shall be determined from:

- the most recent semi-persistent scheduling assignment PDCCH or EPDCCH or MPDCCH or SPDCCH, when the initial PUSCH for the same transport block is semi-persistently scheduled, or,

- the random access response grant for the same transport block, when the PUSCH is initiated by the random access response grant, or

- the most recent AUL activation DCI as defined in [3], when the initial PUSCH for the same transport block is AUL PUSCH.

is the number of SC-FDMA symbols per subframe/slot/subslot for initial PUSCH transmission for the same transport block.

For UL-SCH data information , where

-  is the number of layers the corresponding UL-SCH transport block is mapped onto, and

-  is the scheduled bandwidth for PUSCH transmission in the current subframe/slot/subslot for the transport block, and

-  is the number of SC-FDMA symbols in the current PUSCH transmission subframe/slot/subslot given by , where

-  for PUSCH with slot duration, or for Partial PUSCH Mode 2 or 3, or

-  for PUSCH with subslot duration,

-  is the number of SC-FDMA symbols of the subslot as defined in clause 4.1 of [2],

-  is the number of SC-FDMA symbols for DMRS of the subslot as defined in clause 5.5.2.1.2 of [2]

- otherwise .

-  is equal to 1 for non-BL/CE UEs and BL/CE UEs in CEModeA

- if UE configured with one UL cell is configured to send PUSCH and SRS in the same subframe for the current subframe/slot/subslot, or

- if UE transmits PUSCH and SRS in the same subframe/slot/subslot for the current subframe in the same serving cell, or

- if the PUSCH resource allocation for the current subframe even partially overlaps with the cell-specific SRS subframe and bandwidth configuration defined in clause 5.5.3 of [2], and for PUSCH with slot/subslot duration if the current slot/subslot is the last slot/subslot in a subframe, or

- if the current subframe/slot/subslot in the same serving cell is a UE-specific type-1 SRS subframe as defined in Clause 8.2 of [3], and for PUSCH with slot/subslot duration if the current slot/subslot is the last slot/subslot in a subframe, or

- if the current subframe/slot/subslot in the same serving cell is a UE-specific type-0 SRS subframe as defined in clause 8.2 of [3] and the UE is configured with multiple TAGs, and for PUSCH with slot/subslot duration if the current slot/subslot is the last slot/subslot in a subframe.

- Otherwise  is equal to 0.

-  is equal to 1 when the UE configured for uplink transmission on a LAA SCell is indicated to transmit the PUSCH not starting from the beginning of the first symbol or the seventh symbol of the current subframe, otherwise is equal to 0.

-  is equal to 1 when the UE configured for uplink transmission on a LAA SCell is indicated to transmit the PUSCH up to the second to last symbol of the current subframe and  is equal to 0, otherwise is equal to 0.

In case of CQI/PMI report for more than one DL cell,  is the result of concatenating the CQI/PMI report for each DL cell in increasing order of cell index. For the case where CQI/PMI feedback for more than one CSI process is to be reported,  is the result of concatenating the CQI/PMI reports in increasing order of CSI process index for each DL cell and then in increasing order of cell index.

- If the payload size is less than or equal to 11 bits, the channel coding of the channel quality information is performed according to clause 5.2.2.6.4 with input sequence .

- For payload sizes greater than 11 bits, the CRC attachment, channel coding and rate matching of the channel quality information is performed according to clauses 5.1.1, 5.1.3.1 and 5.1.4.2, respectively. The input bit sequence to the CRC attachment operation is . The output bit sequence of the CRC attachment operation is the input bit sequence to the channel coding operation. The output bit sequence of the channel coding operation is the input bit sequence to the rate matching operation.

The output sequence for the channel coding of channel quality information is denoted by , where  is the number of layers the corresponding UL-SCH transport block is mapped onto.

\*\* unchanged parts skipped \*\*

#### 5.2.3.1 Channel coding for UCI HARQ-ACK on PUCCH

The HARQ-ACK bits are received from higher layers for each subframe of each cell. Each positive acknowledgement (ACK) is encoded as a binary '1' and each negative acknowledgement (NACK) is encoded as a binary '0'. For UEs configured with no more than five DL cells, or for UEs configured by higher layers with *codebooksizeDetermination-r13 = cc*, and for the case where PUCCH format 3, PUCCH format 4 or PUCCH format 5 [2] is configured by higher layers and is used for transmission of the HARQ-ACK feedback information, the HARQ-ACK feedback consists of the concatenation of HARQ-ACK bits for each of the serving cells. For UEs configured by higher layers with *codebooksizeDetermination-r13 = dai*, the HARQ-ACK feedback consists of the HARQ-ACK bits for the serving cells depending on the Downlink Assignment Index (DAI) as in Table 5.3.3.1.2-2 and as defined in [3]. For cells configured with transmission modes 1, 2, 5, 6 or 7 [3], i.e., single codeword transmission modes, 1 bit of HARQ-ACK information, , is used for that cell. For cells configured with other transmission modes, 2 bits of HARQ-ACK information are used for those cells, i.e.,  with  corresponding to HARQ-ACK bit for codeword 0 and  corresponding to that for codeword 1.

Define  as the number of HARQ-ACK feedback bits and  as the number of HARQ-ACK feedback bits including the possible concurrent transmission of scheduling request and/or periodic CSI when PUCCH format 3 is used for transmission of HARQ-ACK feedback (clause 10.1 in [3]), and  as the number of HARQ-ACK feedback bits including the possible concurrent transmission of scheduling request and/or periodic CSI when PUCCH format 4 is used for transmission of HARQ-ACK feedback (clause 10.1 in [3]), and  as the number of HARQ-ACK feedback bits including the possible concurrent transmission of scheduling request and/or periodic CSI when PUCCH format 5 is used for transmission of HARQ-ACK feedback (clause 10.1 in [3]).

For UEs configured by higher layers with *codebooksizeDetermination-r13 = dai*, the bit sequence  is determined according to the Downlink Assignment Index (DAI) as in Table 5.3.3.1.2-2 and as defined in [3]. Otherwise, the bit sequence  is determined as below.

For FDD when the UE is not configured with EN-DC/NE-DC and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC*, the sequence of bits  is the result of the concatenation of HARQ-ACK bits for different cells according to the following pseudo-code:

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

Set *j* = 0 – HARQ-ACK bit index

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

while *c* < 

if transmission mode configured in cell  -- 1 bit HARQ-ACK feedback for this cell

 HARQ-ACK bit of this cell

*j* = *j* + 1

else

if the UE is configured with spatial bundling on PUCCH by higher layers and if the UE is configured with PUCCH format 4 or PUCCH format 5 or PUCCH format 3 with more than 5 serving cells or if HARQ-ACK is to be transmitted on subslot SPUCCH as described in clause 5.2.3.1A

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

*j* = *j* + 1

else

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

*j* = *j* + 1

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

*j* = *j* + 1

end if

end if

*c* = *c* + 1

end while

For the aggregation of more than one DL cell including a primary cell using FDD and at least one secondary cell using TDD when the UE is not configured with EN-DC/NE-DC and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC*, the sequence of bits  is the result of the concatenation of HARQ-ACK bits for different cells. Define  as the number of cells configured by higher layers for the UE and  as the number of subframes for which the UE needs to feed back HARQ-ACK bits in UL subframe n for the *c*-th serving cell. For a cell using TDD, the subframes are determined by the DL-reference UL/DL configuration if the UE is configured with higher layer parameter *eimta-HARQ-ReferenceConfig*, and determined by the UL/DL configuration otherwise. For a cell using TDD,  if subframe n-4 in the cell, or subframe n-3 in the cell if higher layer parameter *shortProcessingTime* is configured for the cell, is a DL subframe or a special subframe with special subframe configurations 1/2/3/4/6/7/8/9/10 and normal downlink CP or a special subframe with special subframe configurations 1/2/3/5/6/7 and extended downlink CP, and  otherwise. For a cell using FDD, .

The sequence of bits  is performed according to the following pseudo-code:

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

Set *j* = 0 – HARQ-ACK bit index

while *c* < 

if 

if transmission mode configured in cell  -- 1 bit HARQ-ACK feedback for this cell

 HARQ-ACK bit of this cell

*j* = *j* + 1

else

if the UE is configured with spatial bundling on PUCCH by higher layers and if the UE is configured with PUCCH format 4 or PUCCH format 5 or PUCCH format 3 with more than 5 serving cells or if HARQ-ACK is to be transmitted on subslot SPUCCH as described in clause 5.2.3.1A

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

*j* = *j* + 1

else

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

*j* = *j* + 1

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

*j* = *j* + 1

end if

end if

*c* = *c* + 1

end while

For the cases with TDD primary cell or EN-DC/NE-DC with FDD primary cell and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC* configured, the sequence of bits  is obtained from the HARQ-ACK bits for different cells and different subframes.

Define  as the number of cells configured by higher layers for the UE and as the number of subframes for which the UE needs to feed back HARQ-ACK bits in cell *c* as defined in Clause 7.3 of [3].

The number of HARQ-ACK bits *k* and the number of HARQ-ACK bits after spatial bundling *kb* are computed as follows:

Set *k* = 0 – counter of HARQ-ACK bits

Set *kb* = 0 – counter of HARQ-ACK bits after spatial bundling

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

while c < 

set *l* = 0;

while *l* < 

if transmission mode configured in cell  -- 1 bit HARQ-ACK feedback for this cell

*k* = *k* + 1

*kb* = *kb* + 1

else

*k* = *k* + 2

*kb* = *kb* + 1

end if

*l* = *l*+1

end while

*c* = *c* + 1

end while

In case the transmission of HARQ-ACK feedback using PUCCH format 3, PUCCH format 4 or PUCCH format 5 coincides with a sub-frame configured to the UE by higher layers for transmission of scheduling request, the number of scheduling request bit *O*SR is 1; otherwise *O*SR=0.

In case the transmission of HARQ-ACK feedback using PUCCH format 3, PUCCH format 4 or PUCCH format 5 coincides with a sub-frame configured to the UE by higher layers for transmission of periodic CSI, *O*CSI is the number of periodic CSI bit(s) for the CSI report as defined in clause 7.2.2 [3]; otherwise *O*CSI=0.

For PUCCH format 3, the number of HARQ-ACK feedback bits  is computed as follows:

If the UE is configured with more than 5 serving cells and spatial bundling on PUCCH is configured, then:

- ,

else, set  when TDD is used in all the configured serving cell(s) of the UE and  when FDD is used in at least one of the configured serving cells with TDD primary cell and  when the UE is configured with EN-DC/NE-DC with FDD primary cell and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC*.

If  and , or if  and , or if  and , then

- 

else,

- .

For PUCCH format 4 or PUCCH format 5,  if the UE is not configured with spatial bundling on PUCCH by higher layers; otherwise .

If  and the HARQ-ACK is to be transmitted on slot SPUCCH or PUCCH, the multiplexing of HARQ-ACK bits is performed according to the following pseudo-code:

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

Set *j* = 0 – HARQ-ACK bit index

while c < 

set *l* = 0;

while *l* < 

if transmission mode configured in cell  -- 1 bit HARQ-ACK feedback for this cell

 HARQ-ACK bit of this cell as defined in Clause 7.3 of [3]

*j* = *j* + 1

else

 HARQ-ACK bit of this cell as defined in Clause 7.3 of [3]

*j* = *j* + 2

end if

*l* = *l*+1

end while

*c* = *c* + 1

end while

If  or if HARQ-ACK is to be transmitted on subslot SPUCCH as described in clause 5.2.3.1A, spatial bundling is applied to all subframes in all cells and the multiplexing of HARQ-ACK bits is performed according to the following pseudo-code

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

Set *j* = 0 – HARQ-ACK bit index

while c < 

set *l* = 0;

while *l* < 

if transmission mode configured in cell  – 1 bit HARQ-ACK feedback for this cell

 HARQ-ACK bit of this cell as defined in Clause 7.3 of [3]

*j* = *j* + 1

else

 binary AND operation of the HARQ-ACK bits corresponding to the first and second codewords of this cell as defined in Clause 7.3 of [3]

*j* = *j* + 1

end if

*l* = *l*+1

end while

*c* = *c* + 1

end while

In case the transmission of HARQ-ACK feedback using PUCCH format 3, PUCCH format 4 or PUCCH format 5 [2] coincides with a sub-frame configured to the UE by higher layers for transmission of scheduling request, the scheduling request bit (1 = positive SR; 0 = negative SR) is appended at the end of the sequence of concatenated HARQ-ACK bits.

In case the transmission of HARQ-ACK feedback using PUCCH format 3, PUCCH format 4 or PUCCH format 5 [2] coincides with a sub-frame configured to the UE by higher layers for transmission of periodic CSI, and periodic CSI is not dropped as defined in clause 7.3.2 and clause 10.1.1 of [3], the periodic CSI bits for the CSI report as defined in clause 7.2.2 [3] are appended at the end of the sequence of concatenated HARQ-ACK bits and scheduling request bit (if any), where in case of CSI report for more than one DL cell, the CSI report for each DL cell is appended in increasing order of cell index. As with the transmission of the scheduling request, the procedure above is used with ,  or  including the number of periodic CSI bits and scheduling request bit (if any).

For , the bit sequence  is obtained by setting .

For , the bit sequence  is obtained by setting  if *i* is even and  if *i* is odd.

For , the sequence of bits  is encoded as follows



where *i* = 0, 1, 2, …, 31 and the basis sequences  are defined in Table 5.2.2.6.4-1.

The output bit sequence  is obtained by circular repetition of the sequence 



where *i* = 0, 1, 2, …, *B*-1 and where .

For , the sequences of bits  and  are encoded as follows



and



where *i* = 0, 1, 2, …, 23 and the basis sequences  are defined in Table 5.2.2.6.4-1.

The output bit sequence  where is obtained by the alternate concatenation of the bit sequences and  as follows

Set *i*, *j* = 0

while 

, 

, 

*i* = *i* + 4

*j* = *j* + 2

end while

For , the bit sequence  is obtained by setting , and the output bit sequence after the rate matching is denoted by , where ,  is the modulation order of the PUCCH format 4,  is determined according to clause 5.2.4.1, and  represents the bandwidth of the PUCCH format 4 in terms of resource blocks [2]. The CRC attachment, channel coding and rate matching are performed according to clauses 5.1.1 by setting *L* to 8 bits, 5.1.3.1 and 5.1.4.2, respectively. The input bit sequence to the CRC attachment operation is . The output bit sequence of the CRC attachment operation is the input bit sequence to the channel coding operation. The output bit sequence of the channel coding operation is the input bit sequence to the rate matching operation.

For , the bit sequence  is obtained by setting , and the output bit sequence after the rate matching is denoted by , where ,  is the modulation order of the PUCCH format 5 and  is determined according to clause 5.2.4.1. The CRC attachment, channel coding and rate matching are performed according to clauses 5.1.1 by setting *L* to 8 bits, 5.1.3.1 and 5.1.4.2, respectively. The input bit sequence to the CRC attachment operation is . The output bit sequence of the CRC attachment operation is the input bit sequence to the channel coding operation. The output bit sequence of the channel coding operation is the input bit sequence to the rate matching operation.

When PUCCH format 3, PUCCH format 4 or PUCCH format 5 is not used for transmission of HARQ-ACK feedback, the HARQ-ACK bits are processed for transmission according to clause 10.1 in [3].

\*\* unchanged parts skipped \*\*

##### 5.3.3.1.1 Format 0

DCI format 0 is used for the scheduling of PUSCH in one UL cell.

The following information is transmitted by means of the DCI format 0:

- Carrier indicator – 0 or 3 bits. This field is present according to the definitions in [3].

- Flag for format0/format1A differentiation – 1 bit, where value 0 indicates format 0 and value 1 indicates format 1A

- Frequency hopping flag – 1 bit as defined in clause 8.4 of [3]. This field is used as the MSB of the corresponding resource allocation field for resource allocation type 1.

- Resource block assignment and hopping resource allocation –  bits

- For PUSCH hopping (resource allocation type 0 only):

- *NUL\_hop* MSB bits are used to obtain the value of  as indicated in clause 8.4 of [3]

-  bits provide the resource allocation of the first slot in the UL subframe

- For non-hopping PUSCH with resource allocation type 0:

-  bits provide the resource allocation in the UL subframe as defined in clause 8.1.1 of [3]

- For non-hopping PUSCH with resource allocation type 1:

- The concatenation of the frequency hopping flag field and the resource block assignment and hopping resource allocation field provides the resource allocation field in the UL subframe as defined in clause 8.1.2 of [3]

- Modulation and coding scheme and redundancy version – 5 bits as defined in clause 8.6 of [3]

- New data indicator – 1 bit

- HARQ process number – 4 bits if higher layer parameter *ul-STTI-Length* is configured for the cell, otherwise 3 bits (this field is present when higher layer parameter *shortProcessingTime* is configured for the cell and the corresponding DCI is mapped onto the UE specific search space given by the C-RNTI as defined in [3])

- Redundancy version – 2 bits (this field is present when higher layer parameter *shortProcessingTime* is configured for the cell and the corresponding DCI is mapped onto the UE specific search space given by the C-RNTI as defined in [3])

- TPC command for scheduled PUSCH – 2 bits as defined in clause 5.1.1.1 of [3]

- Cyclic shift for DM RS and OCC index and IFDMA configuration – 3 bits as defined in clause 5.5.2.1.1 of [2] (this field is not present when the format 0 CRC is scrambled by UL-SPS-V-RNTI)

- UL SPS configuration index – 3 bits as defined in clause 9.2.1 of [3]. (this field is present when the format 0 CRC is scrambled by UL-SPS-V-RNTI)

- UL index – 2 bits as defined in clauses 5.1.1.1, 7.2.1, 8 and 8.4 of [3] (this field is present only for TDD operation with uplink-downlink configuration 0, or TDD operation with uplink-downlink configuration 6 and special subframe configuration 10 when the higher layer parameter *symPUSCH-UpPts* or *shortProcessingTime* is configured for the cell and the corresponding DCI is mapped onto the UE specific search space given by the C-RNTI as defined in [3])

- Downlink Assignment Index (DAI) – 2 bits as defined in clause 7.3 of [3] (this field is present only for the following cases: 1) TDD primary cell and either TDD operation with uplink-downlink configurations 1-6 or FDD operation; or 2) EN-DC/NE-DC with FDD primary cell and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC* configured and the corresponding DCI is mapped onto the UE specific search space given by the C-RNTI as defined in [3])

- CSI request – 1, 2, 3, 4 or 5 bits as defined in clause 7.2.1 of [3].

If UEs are not configured with CSI-RS-ConfigNZPAperiodic or if UEs are configured with CSI-RS-ConfigNZPAperiodic and numberActivatedAperiodicCSI-RS-Resources=1 for each CSI process,

the 2-bit field applies to UEs configured with no more than five DL cells and to

- UEs that are configured with more than one DL cell and when the corresponding DCI format is mapped onto the UE specific search space given by the C-RNTI as defined in [3];

- UEs that are configured by higher layers with more than one CSI process and when the corresponding DCI format is mapped onto the UE specific search space given by the C-RNTI as defined in [3];

- UEs that are configured with two CSI measurement sets by higher layers with the parameter *csi-MeasSubframeSet,* and when the corresponding DCI format is mapped onto the UE specific search space given by the C-RNTI as defined in [3];

the 3-bit field applies to UEs that are configured with more than five DL cells and when the corresponding DCI format is mapped onto the UE specific search space given by the C-RNTI as defined in [3];

otherwise the 1-bit field applies

If UEs are configured with CSI-RS-ConfigNZPAperiodic and numberActivatedAperiodicCSI-RS-Resources>1 for at least one CSI process,

the 4-bit field applies to UEs configured with no more than five DL cells and to

- UEs that are configured with more than one DL cell and when the corresponding DCI format is mapped onto the UE specific search space given by the C-RNTI as defined in [3];

- UEs that are configured by higher layers with more than one CSI process and when the corresponding DCI format is mapped onto the UE specific search space given by the C-RNTI as defined in [3];

- UEs that are configured with two CSI measurement sets by higher layers with the parameter *csi-MeasSubframeSet,* and when the corresponding DCI format is mapped onto the UE specific search space given by the C-RNTI as defined in [3];

the 5-bit field applies to UEs that are configured with more than five DL cells and when the corresponding DCI format is mapped onto the UE specific search space given by the C-RNTI as defined in [3];

otherwise the 3-bit field applies.

- SRS request – 0 or 1 bit. This field can only be present in DCI formats scheduling PUSCH which are mapped onto the UE specific search space given by the C-RNTI as defined in [3]. The interpretation of this field is provided in clause 8.2 of [3]

- Resource allocation type – 1 bit. This field is only present if . The interpretation of this field is provided in clause 8.1 of [3]

- Cyclic Shift Field mapping table for DMRS – 1 bit as defined in clause 5.5.2.1.1 of [2]. The 1-bit field applies to UEs that are configured with higher layer parameter *UL-DMRS-IFDMA*, and when the corresponding DCI format is mapped onto the UE-specific search space given by the C-RNTI as defined in [3]. When the format 0 CRC is scrambled by SPS C-RNTI, this field is set to zero.

If the number of information bits in format 0 mapped onto a given search space is less than the payload size of format 1A for scheduling the same serving cell and mapped onto the same search space (including any padding bits appended to format 1A), zeros shall be appended to format 0 until the payload size equals that of format 1A.

\*\* unchanged parts skipped \*\*

##### 5.3.3.1.1C Format 0C

DCI format 0C is used for the scheduling of PUSCH in one UL cell.

The following information is transmitted by means of the DCI format 0C:

- Flag for format 0C/format1A differentiation – 1 bit, where value 0 indicates format 0C and value 1 indicates format 1A

- Resource allocation type – 1 bit. This field is only present if . The interpretation of this field is provided in clause 8.1 of [3]

- Frequency hopping flag – 1 bit as defined in clause 5.3.4 of [2]. This field is used as the MSB of the corresponding resource allocation field for resource allocation type 1.

- Resource block assignment –  bits

- For PUSCH with resource allocation type 0:

- bits provide the resource allocation in the UL subframe as defined in clause 8.1.1 of [3]

- For non-hopping PUSCH with resource allocation type 1:

- The concatenation of the frequency hopping flag field and the resource block assignment field provides the resource allocation field in the UL subframe as defined in clause 8.1.2 of [3]

- Modulation and coding scheme – 5 bits as defined in clause 8.6 of [3]

- Repetition number – 3 bits as defined in clause 8.0 of [3]

- HARQ process number – 3 bits

- New data indicator – 1 bit

- Redundancy version – 2 bits

- TPC command for scheduled PUSCH – 2 bits as defined in clause 5.1.1.1 of [3]

- Cyclic shift for DM RS and OCC index – 3 bits as defined in clause 5.5.2.1.1 of [2]

- UL index – 2 bits as defined in clauses 5.1.1.1, 7.2.1, 8 and 8.4 of [3] (this field is present only for TDD operation with uplink-downlink configuration 0, or TDD operation with uplink-downlink configuration 6 and special subframe configuration 10 when the higher layer parameter *symPUSCH-UpPts* is configured)

- Downlink Assignment Index (DAI) – 2 bits as defined in clause 7.3 of [3] (This field is present only for the following cases: 1) TDD primary cell and either TDD operation with uplink-downlink configurations 1-6 or FDD operation; or 2) EN-DC/NE-DC with FDD primary cell and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC* configured)

- CSI request – 1, 2 or 3 bits as defined in clause 7.2.1 of [3]. The 2-bit field applies to UEs configured with no more than five DL cells and to

- UEs that are configured with more than one DL cell and when the corresponding DCI format is mapped onto the UE specific search space given by the C-RNTI as defined in [3];

- UEs that are configured by higher layers with more than one CSI process and when the corresponding DCI format is mapped onto the UE specific search space given by the C-RNTI as defined in [3];

- UEs that are configured with two CSI measurement sets by higher layers with the parameter *csi-MeasSubframeSet,* and when the corresponding DCI format is mapped onto the UE specific search space given by the C-RNTI as defined in [3];

the 3-bit field applies to UEs that are configured with more than five DL cells and when the corresponding DCI format is mapped onto the UE specific search space given by the C-RNTI as defined in [3];

otherwise the 1-bit field applies

- SRS request –1 bit. The interpretation of this field is provided in clause 8.2 of [3]

- Modulation order override – 1 bit as defined in clause 8.6.1 of [3]

- Precoding information: number of bits as specified in Table 5.3.3.1.8-1. This field is present only if the higher layer parameter *transmissionModeUL* is configured to be transmission mode 2. Bit field as shown in Table 5.3.3.1.8-2 and Table 5.3.3.1.8-3, where only codeword 0 is enabled and the indexes corresponding to 1 layer are used. Note that TPMI for 2 antenna ports indicates which codebook index is to be used in Table 5.3.3A.2-1 of [2], and TPMI for 4 antenna ports indicates which codebook index is to be used in Table 5.3.3A.2-2, Table 5.3.3A.2-3, Table 5.3.3A.2-4 and Table 5.3.3A.2-5 of [2]. The transport block is mapped to codeword 0.

If the number of information bits in format 0C mapped onto a given search space is less than the payload size of format 1A for scheduling the same serving cell and mapped onto the same search space (including any padding bits appended to format 1A), zeros shall be appended to format 0C until the payload size equals that of format 1A.

##### 5.3.3.1.2 Format 1

DCI format 1 is used for the scheduling of one PDSCH codeword in one cell.

The following information is transmitted by means of the DCI format 1:

- Carrier indicator – 0 or 3 bits. This field is present according to the definitions in [3].

- Resource allocation header (resource allocation type 0 / type 1) – 1 bit as defined in clause 7.1.6 of [3]

If downlink bandwidth is less than or equal to 10 PRBs, there is no resource allocation header and resource allocation type 0 is assumed.

- Resource block assignment:

- For resource allocation type 0 as defined in clause 7.1.6.1 of [3]:

- bits provide the resource allocation

- For resource allocation type 1 as defined in clause 7.1.6.2 of [3]:

-  bits of this field are used as a header specific to this resource allocation type to indicate the selected resource blocks subset

- 1 bit indicates a shift of the resource allocation span

-  bits provide the resource allocation

where the value of P depends on the number of DL resource blocks as indicated in clause 7.1.6.1 of [3]

- Modulation and coding scheme – 5 bits if higher layer parameter *altMCS-Table* is not configured, 6 bits otherwise, as defined in clause 7.1.7 of [3]

- HARQ process number – 4 bits if higher layer parameter *dl-STTI-Length* is configured for the cell, otherwise 3 bits (for cases with FDD primary cell not configured with EN-DC/NE-DC and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC*), 4 bits (for cases with TDD primary cell, or for cases with EN-DC/NE-DC with FDD primary cell and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC* configured)

- New data indicator – 1 bit

- Redundancy version – 2 bits

- TPC command for PUCCH – 2 bits as defined in clause 5.1.2.1 of [3]

- Downlink Assignment Index – number of bits as specified in Table 5.3.3.1.2-2.

- HARQ-ACK resource offset (this field is present when this format is carried by EPDCCH. This field is not present when this format is carried by PDCCH) – 2 bits as defined in clause 10.1 of [3]. The 2 bits are set to 0 when this format is carried by EPDCCH on a secondary cell, or when this format is carried by EPDCCH on the primary cell scheduling PDSCH on a secondary cell and the UE is configured with PUCCH format 3 for HARQ-ACK feedback.

- MUST interference presence and power ratio – 0 or 2 bits as defined in clause 6.3.3 of [2]. This field is present only when the UE is configured for MUST-near operation and the number of antenna ports for CRS transmission in the serving cell is 2.

- Aperiodic zero-power CSI-RS resource indicator for PDSCH RE Mapping – 2 bits as defined in clauses 7.1.9 and 7.2.7 of [3]. This field is present only when the UE is configured with *csi-RS-ConfigZP-ApList*.

If the UE is not configured to decode PDCCH or EPDCCH with CRC scrambled by the C-RNTI and the number of information bits in format 1 is equal to that for format 0/1A, one bit of value zero shall be appended to format 1.

If the UE is configured to decode PDCCH or EPDCCH with CRC scrambled by the C-RNTI and the number of information bits in format 1 is equal to that for format 0/1A for scheduling the same serving cell and mapped onto the UE specific search space given by the C-RNTI as defined in [3], one bit of value zero shall be appended to format 1.

If the number of information bits in format 1 carried by PDCCH belongs to one of the sizes in Table 5.3.3.1.2-1, one or more zero bit(s) shall be appended to format 1 until the payload size of format 1 does not belong to one of the sizes in Table 5.3.3.1.2-1 and is not equal to that of format 0/1A mapped onto the same search space.

Table 5.3.3.1.2-1: Ambiguous Sizes of Information Bits

|  |
| --- |
| {12, 14, 16 ,20, 24, 26, 32, 40, 44, 56} |

Table 5.3.3.1.2-2: Number of bits for Downlink Assignment Index

|  |  |
| --- | --- |
| Number of bits |  |
| 4 | For UEs configured by higher layers with *codebooksizeDetermination-r13 = dai* and when a DCI format 1/1A/1B/1D/2/2A/2B/2C/2D/6-1A scheduling PDSCH is mapped onto the UE specific search space given by the C-RNTI as defined in [3], or UEs configured by higher layers with *codebooksizeDeterminationSTTI = dai* and when a DCI format 7-1A/7-1B/7-1C/7-1D/7-1E/7-1F/7-1G scheduling PDSCH is mapped onto the UE specific search space given by the C-RNTI as defined in [3], the 4-bit DAI consists of a 2-bit counter DAI and a 2-bit total DAI. - Counter DAI – 2 bits as defined in clause 7.3 of [3]- Total DAI – 2 bits as defined in clause 7.3 of [3] |
| 2 | For UEs not configured with *codebooksizeDetermination-r13 = dai* and *codebooksizeDeterminationSTTI-r15=dai*, or for UEs configured by higher layers with *codebooksizeDetermination-r13 = dai* and when a DCI format scheduling PDSCH is not mapped onto the UE specific search space given by the C-RNTI as defined in [3], this field is present for FDD or TDD operation, for cases with TDD primary cell.If the UL/DL configuration of all TDD serving cells is same and the UE is not configured to decode PDCCH with CRC scrambled by *eimta-RNTI*, then this field only applies to serving cell with UL/DL configuration 1-6.If at least two TDD serving cells have different UL/DL configurations or the UE is configured to decode PDCCH with CRC scrambled by *eimta-RNTI*, then this field applies to a serving cell with DL-reference UL/DL configuration 1-6 as defined in clause 10.2 of [3].For UEs configured with EN-DC/NE-DC with FDD primary cell and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC* and a DCI format scheduling PDSCH is mapped onto the UE specific search space given by the C-RNTI as defined in [3], this field is present. |
| 0 | For UEs not configured with *codebooksizeDetermination-r13 = dai* and *codebooksizeDeterminationSTTI-r15=dai* and not configured with EN-DC/NE-DC and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC*, or for UEs configured by higher layers with *codebooksizeDetermination-r13 = dai* and when a DCI format scheduling PDSCH is not mapped onto the UE specific search space given by the C-RNTI as defined in [3], this field is not present for FDD or TDD operation, for cases with FDD primary cell.For UEs configured with EN-DC/NE-DC with FDD primary cell and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC* and a DCI format scheduling PDSCH is not mapped onto the UE specific search space given by the C-RNTI as defined in [3], this field is not present. |

##### 5.3.3.1.3 Format 1A

DCI format 1A is used for the compact scheduling of one PDSCH codeword in one cell and random access procedure initiated by a PDCCH order. The DCI corresponding to a PDCCH order can be carried by PDCCH or EPDCCH.

The following information is transmitted by means of the DCI format 1A:

- Carrier indicator – 0 or 3 bits. This field is present according to the definitions in [3].

- Flag for format0/format1A differentiation or flag for format0A/format1A differentiation – 1 bit, where value 0 indicates format 0 or format 0A and value 1 indicates format 1A

Format 1A is used for random access procedure initiated by a PDCCH order only if format 1A CRC is scrambled with C-RNTI and all the remaining fields are set as follows:

- Localized/Distributed VRB assignment flag – 1 bit is set to '0'

- Resource block assignment – bits, where all bits shall be set to 1

- Preamble Index – 6 bits

- PRACH Mask Index – 4 bits, [5]

- All the remaining bits in format 1A for compact scheduling assignment of one PDSCH codeword are set to zero

Otherwise,

- Localized/Distributed VRB assignment flag – 1 bit as defined in 7.1.6.3 of [3]

- Resource block assignment – bits as defined in clause 7.1.6.3 of [3]:

- For localized VRB:

bits provide the resource allocation

- For distributed VRB:

- If  or if the format 1A CRC is scrambled by RA-RNTI, P-RNTI, SI-RNTI, SC-RNTI or G-RNTI:

- bits provide the resource allocation

- Else

- 1 bit, the MSB indicates the gap value, where value 0 indicates **** and value 1 indicates ****

-  bits provide the resource allocation,

where  is defined in [2].

- Modulation and coding scheme – 5bits as defined in clause 7.1.7 of [3]. The MSB is set to 0 when the UE is configured with *blindSubframePDSCH-Repetitions* set to TRUE and the corresponding DCI is mapped onto the UE specific search space given by the C-RNTI as defined in [3] and the repetition number is greater than 1 and the higher layer parameter *mcs-restrictionSubframePDSCH-Repetitions* is configured to 1.

- HARQ process number – 4 bits if higher layer parameter *dl-STTI-Length* is configured for the cell and the corresponding DCI is mapped onto the UE specific search space given by the C-RNTI as defined in [3], otherwise 3 bits (for cases with FDD primary cell not configured with EN-DC/NE-DC and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC*, or for cases with EN-DC/NE-DC with FDD primary cell and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC* configured and the corresponding DCI is not mapped onto the UE specific search space given by the C-RNTI as defined in [3]), 4 bits (for cases with TDD primary cell, or for cases with EN-DC/NE-DC with FDD primary cell and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC* configured and the corresponding DCI is mapped onto the UE specific search space given by the C-RNTI as defined in [3])

- New data indicator – 1 bit

- If the format 1A CRC is scrambled by RA-RNTI, P-RNTI, SI-RNTI, SC-RNTI or G-RNTI:

- If  and Localized/Distributed VRB assignment flag is set to 1

- the new data indicator bit indicates the gap value, where value 0 indicates **** and value 1 indicates ****.

- Else the new data indicator bit is reserved.

- Else

- The new data indicator bit as defined in [5]

- Redundancy version – 2 bits

- TPC command for PUCCH – 2 bits as defined in clause 5.1.2.1 of [3]

- If the format 1A CRC is scrambled by RA-RNTI, P-RNTI, or SI-RNTI:

- The most significant bit of the TPC command is reserved.

- The least significant bit of the TPC command indicates column of the TBS table defined of [3].

- If least significant bit is 0 then = 2 else= 3.

- Else if the format 1A CRC is scrambled by G-RNTI or SC-RNTI:

- The two bits of the TPC command are reserved

- Else

- The two bits including the most significant bit indicates the TPC command

- Downlink Assignment Index – number of bits as specified in Table 5.3.3.1.2-2.

- SRS request – 0 or 1 bit. This field can only be present in DCI formats scheduling PDSCH which are mapped onto the UE specific search space given by the C-RNTI as defined in [3]. The interpretation of this field is provided in clause 8.2 of [3]. This field is not present when the DCI is used for scheduling PDSCH in a LAA SCell.

- HARQ-ACK resource offset (this field is present when this format is carried by EPDCCH. This field is not present when this format is carried by PDCCH) – 2 bits as defined in clause 10.1 of [3]. The 2 bits are set to 0 when this format is carried by EPDCCH on a secondary cell, or when this format is carried by EPDCCH on the primary cell scheduling PDSCH on a secondary cell and the UE is configured with PUCCH format 3 for HARQ-ACK feedback.

- SRS timing offset – 3 bits as defined in [3]. This field is present only when the DCI format is used for scheduling PDSCH in a LAA SCell and the UE is configured with uplink transmission on the LAA Scell.

- Repetition number – 2 bits as defined in Table 5.3.3.1.17-1, where the number of transmissions for PDSCH is given by higher layer parameter *maxNumber-SubframePDSCH-Repetitions* for the value of '11'. This field is present only when the UE is configured with higher layer parameter *blindSubframePDSCH-Repetitions* set to TRUE and the corresponding DCI is mapped onto the UE specific search space given by the C-RNTI as defined in [3].

If the UE is not configured to decode PDCCH or EPDCCH with CRC scrambled by the C-RNTI, and the number of information bits in format 1A is less than that of format 0, zeros shall be appended to format 1A until the payload size equals that of format 0.

If the UE is configured to decode PDCCH or EPDCCH with CRC scrambled by the C-RNTI and the number of information bits in format 1A mapped onto a given search space is less than that of format 0 for scheduling the same serving cell and mapped onto the same search space, zeros shall be appended to format 1A until the payload size equals that of format 0, except when format 1A assigns downlink resource on a secondary cell without an uplink configuration associated with the secondary cell.

If the UE is configured to decode PDCCH or EPDCCH with CRC scrambled by the C-RNTI and the number of information bits in format 1A mapped onto a given search space is less than that of format 0A for scheduling the same serving cell and mapped onto the same search space, zeros shall be appended to format 1A until the payload size equals that of format 0A, except when format 1A assigns downlink resource on a secondary cell without an uplink configuration associated with the secondary cell.

If the UE is configured to decode PDCCH or EPDCCH with CRC scrambled by the C-RNTI and the number of information bits in format 1A mapped onto a given search space is less than that of format 0C for scheduling the same serving cell and mapped onto the same search space, zeros shall be appended to format 1A until the payload size equals that of format 0C, except when format 1A assigns downlink resource on a secondary cell without an uplink configuration associated with the secondary cell.

If the number of information bits in format 1A carried by PDCCH belongs to one of the sizes in Table 5.3.3.1.2-1, one zero bit shall be appended to format 1A.

When the format 1A CRC is scrambled with a RA-RNTI, P-RNTI, SI-RNTI, SC-RNTI or G-RNTI then the following fields among the fields above are reserved:

- HARQ process number

- Downlink Assignment Index (used for cases with TDD primary cell and either FDD operation or TDD operation, and is not present for cases with FDD primary cell and either FDD operation or TDD operation)

##### 5.3.3.1.3A Format 1B

DCI format 1B is used for the compact scheduling of one PDSCH codeword in one cell with precoding information.

The following information is transmitted by means of the DCI format 1B:

- Carrier indicator – 0 or 3 bits. The field is present according to the definitions in [3].

- Localized/Distributed VRB assignment flag – 1 bit as defined in clause 7.1.6.3 of [3]

- Resource block assignment – bits as defined in clause 7.1.6.3 of [3]

- For localized VRB:

bits provide the resource allocation

- For distributed VRB:

- For 

- bits provide the resource allocation

- For 

- 1 bit, the MSB indicates the gap value, where value 0 indicates **** and value 1 indicates ****

-  bits provide the resource allocation

- Modulation and coding scheme – 5 bits if higher layer parameter *altMCS-Table* is not configured, 6 bits otherwise, as defined in clause 7.1.7 of [3]

- HARQ process number – 4 bits if higher layer parameter *dl-STTI-Length* is configured for the cell, otherwise 3 bits (for cases with FDD primary cell not configured with EN-DC/NE-DC and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC*), 4 bits (for cases with TDD primary cell, or for cases with EN-DC/NE-DC with FDD primary cell and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC* configured)

- New data indicator – 1 bit

- Redundancy version – 2 bits

- TPC command for PUCCH – 2 bits as defined in clause 5.1.2.1 of [3]

- Downlink Assignment Index – number of bits as specified in Table 5.3.3.1.2-2.

- TPMI information for precoding – number of bits as specified in Table 5.3.3.1.3A-1

TPMI information indicates which codebook index is used in Table 6.3.4.2.3-1 or Table 6.3.4.2.3-2 of [2] corresponding to the single-layer transmission.

- PMI confirmation for precoding – 1 bit as specified in Table 5.3.3.1.3A-2

- HARQ-ACK resource offset (this field is present when this format is carried by EPDCCH. This field is not present when this format is carried by PDCCH) – 2 bits as defined in clause 10.1 of [3]. The 2 bits are set to 0 when this format is carried by EPDCCH on a secondary cell, or when this format is carried by EPDCCH on the primary cell scheduling PDSCH on a secondary cell and the UE is configured with PUCCH format 3 for HARQ-ACK feedback.

- Aperiodic zero-power CSI-RS resource indicator for PDSCH RE Mapping – 2 bits as defined in clauses 7.1.9 and 7.2.7 of [3]. This field is present only when the UE is configured with *csi-RS-ConfigZP-ApList*.

If PMI confirmation indicates that the eNodeB has applied precoding according to PMI(s) reported by the UE, the precoding for the corresponding RB(s) in subframe *n* is according to the latest PMI(s) in an aperiodic CSI reported on or before subframe *n-*4.

Table 5.3.3.1.3A-1: Number of bits for TPMI information

|  |  |
| --- | --- |
| Number of antenna ports at eNodeB | Number of bits |
| 2 | 2 |
| 4 | 4 |

Table 5.3.3.1.3A-2: Content of PMI confirmation

|  |  |
| --- | --- |
| Bit field mapped to index | Message |
| 0 | Precoding according to the indicated TPMI in the TPMI information field |
| 1 | Precoding using the precoder(s) according to PMI(s) indicated in the latest aperiodic CSI report.For aperiodic CSI mode 2-2:  - Precoding of scheduled resource blocks belonging to the reported preferred M subband(s), use precoder(s) according to the preferred M subband PMI(s) indicated in the latest aperiodic CSI report;  - Precoding of scheduled resource blocks not belonging to the reported preferred M subband(s), precoding using a precoder according to the wideband PMI indicated in the latest aperiodic CSI report. |

If the number of information bits in format 1B is equal to that for format 0/1A for scheduling the same serving cell and mapped onto the UE specific search space given by the C-RNTI as defined in [3], one bit of value zero shall be appended to format 1B.

If the number of information bits in format 1B carried by PDCCH belongs to one of the sizes in Table 5.3.3.1.2-1, one or more zero bit(s) shall be appended to format 1B until the payload size of format 1B does not belong to one of the sizes in Table 5.3.3.1.2-1 and is not equal to that of format 0/1A mapped onto the same search space.

\*\* unchanged parts skipped \*\*

##### 5.3.3.1.4A Format 1D

DCI format 1D is used for the compact scheduling of one PDSCH codeword in one cell with precoding and power offset information.

The following information is transmitted by means of the DCI format 1D:

- Carrier indicator – 0 or 3 bits. The field is present according to the definitions in [3].

- Localized/Distributed VRB assignment flag – 1 bit as defined in clause 7.1.6.3 of [3]

- Resource block assignment – bits as defined in clause 7.1.6.3 of [3]:

- For localized VRB:

bits provide the resource allocation

- For distributed VRB:

- For 

- bits provide the resource allocation

- For 

- 1 bit, the MSB indicates the gap value, where value 0 indicates **** and value 1 indicates ****

-  bits provide the resource allocation

- Modulation and coding scheme – 5 bits if higher layer parameter *altMCS-Table* is not configured, 6 bits otherwise, as defined in clause 7.1.7 of [3]

- HARQ process number – 4 bits if higher layer parameter *dl-STTI-Length* is configured for the cell, otherwise 3 bits (for cases with FDD primary cell not configured with EN-DC/NE-DC and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC*), 4 bits (for cases with TDD primary cell, or for cases with EN-DC/NE-DC with FDD primary cell and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC* configured)

- New data indicator – 1 bit

- Redundancy version – 2 bits

- TPC command for PUCCH – 2 bits as defined in clause 5.1.2.1 of [3]

- Downlink Assignment Index – number of bits as specified in Table 5.3.3.1.2-2.

- TPMI information for precoding – number of bits as specified in Table 5.3.3.1.4A-1

TPMI information indicates which codebook index is used in Table 6.3.4.2.3-1 or Table 6.3.4.2.3-2 of [2] corresponding to the single-layer transmission.

- Downlink power offset – 1 bit as defined in clause 7.1.5 of [3]

- HARQ-ACK resource offset (this field is present when this format is carried by EPDCCH. This field is not present when this format is carried by PDCCH) – 2 bits as defined in clause 10.1 of [3]. The 2 bits are set to 0 when this format is carried by EPDCCH on a secondary cell, or when this format is carried by EPDCCH on the primary cell scheduling PDSCH on a secondary cell and the UE is configured with PUCCH format 3 for HARQ-ACK feedback.

- Aperiodic zero-power CSI-RS resource indicator for PDSCH RE Mapping – 2 bits as defined in clauses 7.1.9 and 7.2.7 of [3]. This field is present only when the UE is configured with *csi-RS-ConfigZP-ApList*.

Table 5.3.3.1.4A-1: Number of bits for TPMI information

|  |  |
| --- | --- |
| Number of antenna ports at eNodeB | Number of bits |
| 2 | 2 |
| 4 | 4 |

If the number of information bits in format 1D is equal to that for format 0/1A for scheduling the same serving cell and mapped onto the UE specific search space given by the C-RNTI as defined in [3], one bit of value zero shall be appended to format 1D.

If the number of information bits in format 1D carried by PDCCH belongs to one of the sizes in Table 5.3.3.1.2-1, one or more zero bit(s) shall be appended to format 1D until the payload size of format 1D does not belong to one of the sizes in Table 5.3.3.1.2-1 and is not equal to that of format 0/1A mapped onto the same search space.

##### 5.3.3.1.5 Format 2

The following information is transmitted by means of the DCI format 2:

- Carrier indicator – 0 or 3 bits. The field is present according to the definitions in [3].

- Resource allocation header (resource allocation type 0 / type 1) – 1 bit as defined in clause 7.1.6 of [3]

If downlink bandwidth is less than or equal to 10 PRBs, there is no resource allocation header and resource allocation type 0 is assumed.

- Resource block assignment:

- For resource allocation type 0 defined in clause 7.1.6.1 of [3]:

- bits provide the resource allocation

- For resource allocation type 1 as defined in clause 7.1.6.2 of [3]:

-  bits of this field are used as a header specific to this resource allocation type to indicate the selected resource blocks subset

- 1 bit indicates a shift of the resource allocation span

-  bits provide the resource allocation

where the value of P depends on the number of DL resource blocks as indicated in clause 7.1.6.1 of [3]

- TPC command for PUCCH – 2 bits as defined in clause 5.1.2.1 of [3]

- Downlink Assignment Index – number of bits as specified in Table 5.3.3.1.2-2.

- HARQ process number - 4 bits if higher layer parameter *dl-STTI-Length* is configured for the cell, otherwise 3 bits (for cases with FDD primary cell not configured with EN-DC/NE-DC and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC*), 4 bits (for cases with TDD primary cell, or for cases with EN-DC/NE-DC with FDD primary cell and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC* configured)

- Transport block to codeword swap flag – 1 bit

In addition, for transport block 1:

- Modulation and coding scheme – 5 bits if higher layer parameter *altMCS-Table* is not configured, 6 bits otherwise, as defined in clause 7.1.7 of [3]

- New data indicator – 1 bit

- Redundancy version – 2 bits

- MUST interference presence and power ratio – 0 or 2 bits as defined in clause 6.3.3 of [2]. This field is present only when the UE is configured for MUST-near operation and the number of antenna ports for CRS transmission in the serving cell is 2

In addition, for transport block 2:

- Modulation and coding scheme – 5 bits if higher layer parameter *altMCS-Table* is not configured, 6 bits otherwise, as defined in clause 7.1.7 of [3]

- New data indicator – 1 bit

- Redundancy version – 2 bits

- MUST interference presence and power ratio – 0 or 2 bits as defined in clause 6.3.3 of [2]. This field is present only when the UE is configured for MUST-near operation and the number of antenna ports for CRS transmission in the serving cell is 2

Precoding information – number of bits as specified in Table 5.3.3.1.5-3

- HARQ-ACK resource offset (this field is present when this format is carried by EPDCCH. This field is not present when this format is carried by PDCCH) – 2 bits as defined in clause 10.1 of [3]. The 2 bits are set to 0 when this format is carried by EPDCCH on a secondary cell, or when this format is carried by EPDCCH on the primary cell scheduling PDSCH on a secondary cell and the UE is configured with PUCCH format 3 for HARQ-ACK feedback.

- Aperiodic zero-power CSI-RS resource indicator for PDSCH RE Mapping – 2 bits as defined in clauses 7.1.9 and 7.2.7 of [3]. This field is present only when the UE is configured with *csi-RS-ConfigZP-ApList*.

If both transport blocks are enabled, the transport block to codeword mapping is specified according to Table 5.3.3.1.5‑1.

In case one of the transport blocks is disabled as specified in clause 7.1.7.2 of [3], the transport block to codeword swap flag is reserved and the transport block to codeword mapping is specified according to Table 5.3.3.1.5‑2.

Table 5.3.3.1.5-1: Transport block to codeword mapping
(two transport blocks enabled)

|  |  |  |
| --- | --- | --- |
| transport blockto codewordswap flag value | codeword 0(enabled) | codeword 1(enabled) |
| 0 | transport block 1 | transport block 2 |
| 1 | transport block 2 | transport block 1 |

Table 5.3.3.1.5-2: Transport block to codeword mapping
(one transport block enabled)

|  |  |  |  |
| --- | --- | --- | --- |
| transport block 1 | transport block 2 | codeword 0(enabled) | codeword 1(disabled) |
| enabled | disabled | transport block 1 | - |
| disabled | enabled | transport block 2 | - |

The interpretation of the precoding information field depends on the number of enabled codewords according to Table 5.3.3.1.5-4 and Table 5.3.3.1.5-5. Note that TPMI indicates which codebook index is used in Table 6.3.4.2.3-1 or Table 6.3.4.2.3-2 of [2]. For a single enabled codeword, indices 18 to 34 inclusive in Table 5.3.3.1.5-5 are only supported for retransmission of the corresponding transport block if that transport block has previously been transmitted using two layers with closed-loop spatial multiplexing.

If the number of information bits in format 2 carried by PDCCH belongs to one of the sizes in Table 5.3.3.1.2-1, one zero bit shall be appended to format 2.

Some entries in Table 5.3.3.1.5-4 and Table 5.3.3.1.5-5 are used for indicating that the eNodeB has applied precoding according to PMI(s) reported by the UE. In these cases the precoding for the corresponding RB(s) in subframe *n* is according to the latest PMI(s) in an aperiodic CSI reported on or before subframe *n*-4. For aperiodic CSI mode 2-2: Precoding of scheduled resource blocks belonging to the reported preferred M subband(s) use precoder(s) according to the preferred M subband PMI indicated by the latest aperiodic CSI report; Precoding of scheduled resource blocks not belonging to the reported preferred M subband(s) use a precoder according to the wideband PMI indicated by the latest aperiodic CSI report.

Table 5.3.3.1.5-3: Number of bits for precoding information

|  |  |
| --- | --- |
| Number of antenna ports at eNodeB | Number of bits for precoding information |
| 2 | 3 |
| 4 | 6 |

Table 5.3.3.1.5-4: Content of precoding information field for 2 antenna ports

|  |  |
| --- | --- |
| One codeword: Codeword 0 enabled, Codeword 1 disabled | Two codewords: Codeword 0 enabled, Codeword 1 enabled |
| **Bit field mapped to index** | **Message** | **Bit field mapped to index** | **Message** |
| 0 | 2 layers: Transmit diversity | 0 | 2 layers: Precoding corresponding to precoder matrix  |
| 1 | 1 layer: Precoding corresponding to precoding vector  | 1 | 2 layers: Precoding corresponding to precoder matrix  |
| 2 | 1 layer: Precoding corresponding to precoder vector  | 2 | 2 layers: Precoding according to the latest PMI report on PUSCH, using the precoder(s) indicated by the reported PMI(s) |
| 3 | 1 layer: Precoding corresponding to precoder vector  | 3 | reserved |
| 4 | 1 layer: Precoding corresponding to precoder vector  | 4 | reserved |
| 5 | 1 layer: Precoding according to the latest PMI report on PUSCH, using the precoder(s) indicated by the reported PMI(s),if RI=2 was reported, using 1st column multiplied by of all precoders implied by the reported PMI(s) | 5 | reserved |
| 6 | 1 layer:Precoding according to the latest PMI report on PUSCH, using the precoder(s) indicated by the reported PMI(s),if RI=2 was reported, using 2nd column multiplied by of all precoders implied by the reported PMI(s) | 6 | reserved |
| 7 | reserved | 7 | reserved |

Table 5.3.3.1.5-5: Content of precoding information field for 4 antenna ports

|  |  |
| --- | --- |
| One codeword: Codeword 0 enabled, Codeword 1 disabled | Two codewords: Codeword 0 enabled, Codeword 1 enabled |
| **Bit field mapped to index** | **Message** | **Bit field mapped to index** | **Message** |
| 0 | 4 layers: Transmit diversity | 0 | 2 layers: TPMI=0 |
| 1 | 1 layer: TPMI=0 | 1 | 2 layers: TPMI=1 |
| 2 | 1 layer: TPMI=1 |  |  |
|  |  | 15 | 2 layers: TPMI=15 |
| 16 | 1 layer: TPMI=15 | 16 | 2 layers: Precoding according to the latest PMI report on PUSCH using the precoder(s) indicated by the reported PMI(s) |
| 17 | 1 layer: Precoding according to the latest PMI report on PUSCH using the precoder(s) indicated by the reported PMI(s) | 17 | 3 layers: TPMI=0 |
| 18 | 2 layers: TPMI=0 | 18 | 3 layers: TPMI=1 |
| 19 | 2 layers: TPMI=1 |  |  |
|  |  | 32 | 3 layers: TPMI=15 |
| 33 | 2 layers: TPMI=15 | 33 |  3 layers: Precoding according to the latest PMI report on PUSCH using the precoder(s) indicated by the reported PMI(s) |
| 34 | 2 layers: Precoding according to the latest PMI report on PUSCH using the precoder(s) indicated by the reported PMI(s) | 34 | 4 layers: TPMI=0 |
| 35 – 63 | reserved | 35 | 4 layers: TPMI=1 |
|  |  |  |  |
|  |  | 49 | 4 layers: TPMI=15 |
|  |  | 50 | 4 layers: Precoding according to the latest PMI report on PUSCH using the precoder(s) indicated by the reported PMI(s) |
|  |  | 51 – 63 | Reserved |

##### 5.3.3.1.5A Format 2A

The following information is transmitted by means of the DCI format 2A:

- Carrier indicator – 0 or 3 bits. The field is present according to the definitions in [3].

- Resource allocation header (resource allocation type 0 / type 1) – 1 bit as defined in clause 7.1.6 of [3]

If downlink bandwidth is less than or equal to 10 PRBs, there is no resource allocation header and resource allocation type 0 is assumed.

- Resource block assignment:

- For resource allocation type 0 as defined in clause 7.1.6.1 of [3]

- bits provide the resource allocation

- For resource allocation type 1 as defined in clause 7.1.6.2 of [3]

-  bits of this field are used as a header specific to this resource allocation type to indicate the selected resource blocks subset

- 1 bit indicates a shift of the resource allocation span

-  bits provide the resource allocation

where the value of P depends on the number of DL resource blocks as indicated in clause 7.1.6.1 of [3]

- TPC command for PUCCH – 2 bits as defined in clause 5.1.2.1 of [3]

- Downlink Assignment Index – number of bits as specified in Table 5.3.3.1.2-2.

- HARQ process number - 4 bits if higher layer parameter *dl-STTI-Length* is configured for the cell, otherwise 3 bits (for cases with FDD primary cell not configured with EN-DC/NE-DC and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC*), 4 bits (for cases with TDD primary cell, or for cases with EN-DC/NE-DC with FDD primary cell and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC* configured)

- Transport block to codeword swap flag – 1 bit

In addition, for transport block 1:

- Modulation and coding scheme – 5 bits if higher layer parameter *altMCS-Table* is not configured, 6 bits otherwise, as defined in clause 7.1.7 of [3]

- New data indicator – 1 bit

- Redundancy version – 2 bits

In addition, for transport block 2:

- Modulation and coding scheme – 5 bits if higher layer parameter *altMCS-Table* is not configured, 6 bits otherwise, as defined in clause 7.1.7 of [3]

- New data indicator – 1 bit

- Redundancy version – 2 bits

- Precoding information – number of bits as specified in Table 5.3.3.1.5A-1

- HARQ-ACK resource offset (this field is present when this format is carried by EPDCCH. This field is not present when this format is carried by PDCCH) – 2 bits as defined in clause 10.1 of [3]. The 2 bits are set to 0 when this format is carried by EPDCCH on a secondary cell, or when this format is carried by EPDCCH on the primary cell scheduling PDSCH on a secondary cell and the UE is configured with PUCCH format 3 for HARQ-ACK feedback. - MUST interference presence and power ratio – 0 or 2 bits as defined in clause 6.3.3 of [2]. This field is present only when the UE is configured for MUST-near operation and the number of antenna ports for CRS transmission in the serving cell is 2.

- Aperiodic zero-power CSI-RS resource indicator for PDSCH RE Mapping – 2 bits as defined in clauses 7.1.9 and 7.2.7 of [3]. This field is present only when the UE is configured with *csi-RS-ConfigZP-ApList*.

If both transport blocks are enabled, the transport block to codeword mapping is specified according to Table 5.3.3.1.5‑1.

In case one of the transport blocks is disabled, the transport block to codeword swap flag is reserved and the transport block to codeword mapping is specified according to Table 5.3.3.1.5‑2.

The precoding information field is defined according to Table 5.3.3.1.5A‑2. For a single enabled codeword, index 1 in Table 5.3.3.1.5A-2 is only supported for retransmission of the corresponding transport block if that transport block has previously been transmitted using two layers with large delay CDD.

For transmission with 2 antenna ports, the precoding information field is not present. The number of transmission layers is equal to 2 if both codewords are enabled; transmit diversity is used if codeword 0 is enabled while codeword 1 is disabled.

If the number of information bits in format 2A carried by PDCCH belongs to one of the sizes in Table 5.3.3.1.2-1, one zero bit shall be appended to format 2A.

Table 5.3.3.1.5A-1: Number of bits for precoding information

|  |  |
| --- | --- |
| Number of antenna ports at eNodeB | Number of bits for precoding information |
| 2 | 0 |
| 4 | 2 |

Table 5.3.3.1.5A-2: Content of precoding information field for 4 antenna ports

|  |  |
| --- | --- |
| One codeword: Codeword 0 enabled, Codeword 1 disabled | Two codewords: Codeword 0 enabled, Codeword 1 enabled |
| **Bit field mapped to index** | **Message** | **Bit field mapped to index** | **Message** |
| 0 | 4 layers: Transmit diversity | 0 | 2 layers: precoder cycling with large delay CDD |
| 1 | 2 layers: precoder cycling with large delay CDD | 1 | 3 layers: precoder cycling with large delay CDD |
| 2 | reserved | 2 | 4 layers: precoder cycling with large delay CDD |
| 3 | reserved | 3 | reserved |

##### 5.3.3.1.5B Format 2B

The following information is transmitted by means of the DCI format 2B:

- Carrier indicator – 0 or 3 bits. The field is present according to the definitions in [3].

- Resource allocation header (resource allocation type 0 / type 1) – 1 bit as defined in clause 7.1.6 of [3]

If downlink bandwidth is less than or equal to 10 PRBs, there is no resource allocation header and resource allocation type 0 is assumed.

- Resource block assignment:

- For resource allocation type 0 as defined in clause 7.1.6.1 of [3]

- bits provide the resource allocation

- For resource allocation type 1 as defined in clause 7.1.6.2 of [3]

-  bits of this field are used as a header specific to this resource allocation type to indicate the selected resource blocks subset

- 1 bit indicates a shift of the resource allocation span

-  bits provide the resource allocation

where the value of P depends on the number of DL resource blocks as indicated in clause [7.1.6.1] of [3]

- TPC command for PUCCH – 2 bits as defined in clause 5.1.2.1 of [3]

- Downlink Assignment Index – number of bits as specified in Table 5.3.3.1.2-2.

- HARQ process number - 4 bits if higher layer parameter *dl-STTI-Length* is configured for the cell, otherwise 3 bits (for cases with FDD primary cell not configured with EN-DC/NE-DC and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC*), 4 bits (for cases with TDD primary cell, or for cases with EN-DC/NE-DC with FDD primary cell and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC* configured)

- Scrambling identity– 1 bit as defined in clause 6.10.3.1 of [2]

- SRS request – [0-1] bit. This field can only be present for TDD operation and if present is defined in clause 8.2 of [3]

In addition, for transport block 1:

- Modulation and coding scheme – 5 bits if higher layer parameter *altMCS-Table* is not configured, 6 bits otherwise, as defined in clause 7.1.7 of [3]

- New data indicator – 1 bit

- Redundancy version – 2 bits

In addition, for transport block 2:

- Modulation and coding scheme – 5 bits if higher layer parameter *altMCS-Table* is not configured, 6 bits otherwise, as defined in clause 7.1.7 of [3]

- New data indicator – 1 bit

- Redundancy version – 2 bits

- HARQ-ACK resource offset (this field is present when this format is carried by EPDCCH. This field is not present when this format is carried by PDCCH) – 2 bits as defined in clause 10.1 of [3]. The 2 bits are set to 0 when this format is carried by EPDCCH on a secondary cell, or when this format is carried by EPDCCH on the primary cell scheduling PDSCH on a secondary cell and the UE is configured with PUCCH format 3 for HARQ-ACK feedback.

- MUST interference presence and modulation (This field is present only when the UE is configured for MUST operation) – 0 or 2 bits. The field is defined in Table 5.3.3.1.5C-3, where the interfering antenna port is in {7,8} excluding the antenna port for transmission. The interfering antenna port has the same scrambling identity as indicated in the "Scrambling identity" field.

- SRS timing offset – 3 bits as defined in [3]. This field is present only when the DCI format is used for scheduling PDSCH in a LAA SCell and the UE is configured with uplink transmission on the LAA SCell.

- Aperiodic zero-power CSI-RS resource indicator for PDSCH RE Mapping – 2 bits as defined in clauses 7.1.9 and 7.2.7 of [3]. This field is present only when the UE is configured with *csi-RS-ConfigZP-ApList*.

If both transport blocks are enabled, the number of layers equals two; transport block 1 is mapped to codeword 0; and transport block 2 is mapped to codeword 1. Antenna ports 7 and 8 are used for spatial multiplexing.

In case one of the transport blocks is disabled, the number of layers equals one; the transport block to codeword mapping is specified according to Table 5.3.3.1.5‑2; and the antenna port for single-antenna port transmission is according to Table 5.3.3.1.5B-1.

Table 5.3.3.1.5B-1: Antenna port for single-antenna port transmission (one transport block disabled)

|  |  |
| --- | --- |
| New data indicator of the disabled transport block | Antenna port  |
| 0 | 7 |
| 1 | 8 |

If the number of information bits in format 2B carried by PDCCH belongs to one of the sizes in Table 5.3.3.1.2-1, one zero bit shall be appended to format 2B.

##### 5.3.3.1.5C Format 2C

The following information is transmitted by means of the DCI format 2C:

- Carrier indicator – 0 or 3 bits. The field is present according to the definitions in [3].

- Resource allocation header (resource allocation type 0 / type 1) – 1 bit as defined in clause 7.1.6 of [3]

If downlink bandwidth is less than or equal to 10 PRBs, there is no resource allocation header and resource allocation type 0 is assumed.

- Resource block assignment:

- For resource allocation type 0 as defined in clause 7.1.6.1 of [3]

- bits provide the resource allocation

- For resource allocation type 1 as defined in clause 7.1.6.2 of [3]

-  bits of this field are used as a header specific to this resource allocation type to indicate the selected resource blocks subset

- 1 bit indicates a shift of the resource allocation span

-  bits provide the resource allocation

where the value of *P* depends on the number of DL resource blocks as indicated in clause [7.1.6.1] of [3]

- TPC command for PUCCH – 2 bits as defined in clause 5.1.2.1 of [3]

- Downlink Assignment Index – number of bits as specified in Table 5.3.3.1.2-2.

- HARQ process number - 4 bits if higher layer parameter *dl-STTI-Length* is configured for the cell, otherwise 3 bits (for cases with FDD primary cell not configured with EN-DC/NE-DC and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC*), 4 bits (for cases with TDD primary cell, or for cases with EN-DC/NE-DC with FDD primary cell and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC* configured)

- Antenna port(s), scrambling identity and number of layers – 3 bits as specified in Table 5.3.3.1.5C-1 where *nSCID* is the scrambling identity for antenna ports 7 and 8 defined in clause 6.10.3.1 of [2], or 4 bits as specified in Table 5.3.3.1.5C-2 where *nSCID* is the scrambling identity for antenna ports 7, 8, 11 and 13 defined in clause 6.10.3.1 of [2] when higher layer parameter *dmrs-tableAlt* is set to 1, or 1 bit as specified in Table 5.3.3.1.5C-6 where *nSCID* is the scrambling identity for antenna ports 7 and 8 defined in clause 6.10.3.1 of [2] when higher layer parameter *semiOpenLoop* is configured.

- SRS request – [0-1] bit. This field can only be present for TDD operation and if present is defined in clause 8.2 of [3]

In addition, for transport block 1:

- Modulation and coding scheme – 5 bits if higher layer parameter *altMCS-Table* is not configured, 6 bits otherwise, as defined in clause 7.1.7 of [3]

- New data indicator – 1 bit

- Redundancy version – 2 bits

In addition, for transport block 2:

- Modulation and coding scheme – 5 bits if higher layer parameter *altMCS-Table* is not configured, 6 bits otherwise, as defined in clause 7.1.7 of [3]

- New data indicator – 1 bit

- Redundancy version – 2 bits

- HARQ-ACK resource offset (this field is present when this format is carried by EPDCCH. This field is not present when this format is carried by PDCCH) – 2 bits as defined in clause 10.1 of [3]. The 2 bits are set to 0 when this format is carried by EPDCCH on a secondary cell, or when this format is carried by EPDCCH on the primary cell scheduling PDSCH on a secondary cell and the UE is configured with PUCCH format 3 for HARQ-ACK feedback.

- MUST interference presence, antenna port, and modulation (this field is only present when the UE is configured for MUST operation) – 2 bits when higher layer parameter *dmrs-tableAlt* is not configured or is set to 0, 4 bits when higher layer parameter *k-max* is set to 1 and *dmrs-tableAlt* =1, or 6 bits when *k-max* is set to 3 and *dmrs-tableAlt* =1. For the 2 and 6 bit fields, two bits are defined for each interfering antenna port in Table 5.3.3.1.5C-3, where a single interfering antenna port is in {7,8} excluding the antenna port for transmission, and multiple interfering antenna ports are in {7,8,11,13} excluding the antenna ports for transmission. For the 6 bit field, the two or four LSB are reserved in the case of two or one interfering antenna port, respectively. Each pair of the used bits in 6 bit field from MSB to LSB is associated with one interfering antenna port in increasing order of port index. For the 4 bit field, two MSB are defined for interference presence and antenna port in Table 5.3.3.1.5C-4 where the single interfering antenna port is one of {7,8,11,13} excluding the antenna port for transmission, and two LSB are defined for interference modulation in 5.3.3.1.5C-5. The interfering antenna port(s) have the same scrambling identity and OCC length as indicated in the "Antenna port(s), scrambling identity and number of layers" field.

- SRS timing offset – 3 bits as defined in [3]. This field is present only when the DCI format is used for scheduling PDSCH in a LAA SCell and the UE is configured with uplink transmission on the LAA SCell.

- Aperiodic zero-power CSI-RS resource indicator for PDSCH RE Mapping – 2 bits as defined in clauses 7.1.9 and 7.2.7 of [3]. This field is present only when the UE is configured with *csi-RS-ConfigZP-ApList*.

If both transport blocks are enabled; transport block 1 is mapped to codeword 0; and transport block 2 is mapped to codeword 1. When higher layer parameter *semiOpenLoop* is configured, antenna ports 7 and 8 are used for spatial multiplexing.

In case one of the transport blocks is disabled; the transport block to codeword mapping is specified according to Table 5.3.3.1.5‑2. For the single enabled codeword, Value = 4, 5, 6 in Table 5.3.3.1.5C-1 or Value = 12, 13,14 in Table 5.3.3.1.5C-2 are only supported for retransmission of the corresponding transport block if that transport block has previously been transmitted using two, three or four layers, respectively. When higher layer parameter *semiOpenLoop* is configured, antenna ports 7 and 8 are used for transmit diversity.

If the number of information bits in format 2C carried by PDCCH belongs to one of the sizes in Table 5.3.3.1.2-1, one zero bit shall be appended to format 2C.

Table 5.3.3.1.5C-1: Antenna port(s), scrambling identity and number of layers indication

|  |  |
| --- | --- |
| One Codeword:Codeword 0 enabled,Codeword 1 disabled | Two Codewords:Codeword 0 enabled,Codeword 1 enabled |
| **Value** | **Message** | **Value** | **Message** |
| 0 | 1 layer, port 7, *nSCID*=0 | 0 | 2 layers, ports 7-8, *nSCID*=0 |
| 1 | 1 layer, port 7, *nSCID*=1 | 1 | 2 layers, ports 7-8, *nSCID*=1 |
| 2 | 1 layer, port 8, *nSCID*=0 | 2 | 3 layers, ports 7-9 |
| 3 | 1 layer, port 8, *nSCID*=1 | 3 | 4 layers, ports 7-10 |
| 4 | 2 layers, ports 7-8 | 4 | 5 layers, ports 7-11 |
| 5 | 3 layers, ports 7-9 | 5 | 6 layers, ports 7-12 |
| 6 | 4 layers, ports 7-10 | 6 | 7 layers, ports 7-13 |
| 7 | Reserved | 7 | 8 layers, ports 7-14 |

Table 5.3.3.1.5C-2: Antenna port(s), scrambling identity and number of layers indication

|  |  |
| --- | --- |
| One Codeword:Codeword 0 enabled,Codeword 1 disabled | Two Codewords:Codeword 0 enabled,Codeword 1 enabled |
| **Value** | **Message** | **Value** | **Message** |
| 0 |  1 layer, port 7, *nSCID*=0 (OCC=2) | 0 | 2 layer, port 7-8, *nSCID*=0 (OCC=2) |
| 1 | 1 layer, port 7, *nSCID*=1 (OCC=2) | 1 | 2 layer, port 7-8, *nSCID*=1 (OCC=2) |
| 2 | 1 layer, port 8, *nSCID*=0 (OCC=2) | 2 | 2 layer, port 7-8, *nSCID*=0 (OCC=4) |
| 3 | 1 layer, port 8, *nSCID*=1 (OCC=2) | 3 | 2 layer, port 7-8, *nSCID*=1 (OCC=4) |
| 4 |  1 layer, port 7, *nSCID*=0 (OCC=4) | 4 |  2 layer, port 11,13, *nSCID*=0 (OCC=4) |
| 5 | 1 layer, port 7, *nSCID*=1 (OCC=4) | 5 | 2 layer, port 11,13, *nSCID*=1 (OCC=4) |
| 6 | 1 layer, port 8, *nSCID*=0 (OCC=4) | 6 | 3 layer, port 7-9 |
| 7 | 1 layer, port 8, *nSCID*=1 (OCC=4) | 7 | 4 layer, port 7-10 |
| 8 | 1 layer, port 11, *nSCID*=0 (OCC=4) | 8 | 5 layer, port 7-11 |
| 9 | 1 layer, port 11, *nSCID*=1 (OCC=4) | 9 | 6 layer, port 7-12 |
| 10 | 1 layer, port 13, *nSCID*=0 (OCC=4) | 10 | 7 layers, ports 7-13 |
| 11 | 1 layer, port 13, *nSCID*=1 (OCC=4) | 11 | 8 layers, ports 7-14 |
| 12 | 2 layers, ports 7-8 | 12 | 3 layers, ports 7, 8,11, *nSCID*=0 (OCC=4) |
| 13 | 3 layers, ports 7-9 | 13 | 4 layers, ports 7, 8,11,13, *nSCID*=0 (OCC=4) |
| 14 | 4 layers, ports 7-10 | 14 | Reserved |
| 15 | Reserved | 15 | Reserved |

Table 5.3.3.1.5C-3: Content of MUST interference presence and modulation for an antenna port

|  |  |
| --- | --- |
| Bit field | Message |
| 00 | No interference presence |
| 01 | Interference is present with QPSK |
| 10 | Interference is present with 16QAM |
| 11 | Interference is present with 64QAM or 256QAM |

Table 5.3.3.1.5C-4: Content of MUST interference presence and antenna port

|  |  |
| --- | --- |
| Bit field | Message |
| 00 | No interference presence |
| 01 | First antenna port |
| 10 | Second antenna port |
| 11 | Third antenna port |

Table 5.3.3.1.5C-5: Content of MUST interference modulation

|  |  |
| --- | --- |
| Bit field | Message |
| 00 | QPSK |
| 01 | 16QAM |
| 10 | 64QAM |
| 11 | 256QAM |

Table 5.3.3.1.5C-6: Antenna port(s), scrambling identity and number of layers indication

|  |
| --- |
| One Codeword:Codeword 0 enabled, Codeword 1 disabledOrTwo Codewords:Codeword 0 enabled, Codeword 1 enabled |
| **Value** | **Message** |
| 0 | 2 layer, port 7-8, *nSCID*=0 |
| 1 | 2 layer, port 7-8, *nSCID*=1 |

##### 5.3.3.1.5D Format 2D

The following information is transmitted by means of the DCI format 2D:

- Carrier indicator – 0 or 3 bits. The field is present according to the definitions in [3].

- Resource allocation header (resource allocation type 0 / type 1) – 1 bit as defined in clause 7.1.6 of [3]

If downlink bandwidth is less than or equal to 10 PRBs, there is no resource allocation header and resource allocation type 0 is assumed.

- Resource block assignment:

- For resource allocation type 0 as defined in clause 7.1.6.1 of [3]

- bits provide the resource allocation

- For resource allocation type 1 as defined in clause 7.1.6.2 of [3]

-  bits of this field are used as a header specific to this resource allocation type to indicate the selected resource blocks subset

- 1 bit indicates a shift of the resource allocation span

-  bits provide the resource allocation

where the value of *P* depends on the number of DL resource blocks as indicated in clause [7.1.6.1] of [3]

- TPC command for PUCCH – 2 bits as defined in clause 5.1.2.1 of [3]

- Downlink Assignment Index – number of bits as specified in Table 5.3.3.1.2-2.

- HARQ process number - 4 bits if higher layer parameter *dl-STTI-Length* is configured for the cell, otherwise 3 bits (for cases with FDD primary cell not configured with EN-DC/NE-DC and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC*), 4 bits (for cases with TDD primary cell, or for cases with EN-DC/NE-DC with FDD primary cell and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC* configured)

- Antenna port(s), scrambling identity and number of layers – 3 bits as specified in Table 5.3.3.1.5C-1 (or Table 5.3.3.1.5D-1 for two codewords when higher layer parameter *qcl-Operation* is set to 'typeC') where *nSCID* is the scrambling identity for antenna ports 7 and 8 defined in clause 6.10.3.1 of [2], or 4 bits as specified in Table 5.3.3.1.5C-2 (or Table 5.3.3.1.5D-2 for two codewords when higher layer parameter *qcl-Operation* is set to 'typeC') where *nSCID* is the scrambling identity for antenna ports 7, 8, 11 and 13 defined in clause 6.10.3.1 of [2] when higher layer parameter *dmrs-tableAlt* is set to 1, or 1 bit as specified in Table 5.3.3.1.5C-6 where *nSCID* is the scrambling identity for antenna ports 7 and 8 defined in clause 6.10.3.1 of [2] when higher layer parameter *semiOpenLoop* is configured.

- SRS request – [0-1] bit. This field can only be present for TDD operation and if present is defined in clause 8.2 of [3]

In addition, for transport block 1:

- Modulation and coding scheme – 5 bits if higher layer parameter *altMCS-Table* is not configured, 6 bits otherwise, as defined in clause 7.1.7 of [3]

- New data indicator – 1 bit

- Redundancy version – 2 bits

In addition, for transport block 2:

- Modulation and coding scheme – 5 bits if higher layer parameter *altMCS-Table* is not configured, 6 bits otherwise, as defined in clause 7.1.7 of [3]

- New data indicator – 1 bit

- Redundancy version – 2 bits

- PDSCH RE Mapping and Quasi-Co-Location Indicator – 2 bits as defined in clauses 7.1.9 and 7.1.10 of [3]

- HARQ-ACK resource offset (this field is present when this format is carried by EPDCCH. This field is not present when this format is carried by PDCCH) – 2 bits as defined in clause 10.1 of [3]. The 2 bits are set to 0 when this format is carried by EPDCCH on a secondary cell, or when this format is carried by EPDCCH on the primary cell scheduling PDSCH on a secondary cell and the UE is configured with PUCCH format 3 for HARQ-ACK feedback.

- MUST interference presence, antenna port, and modulation (this field is only present when the UE is configured for MUST operation) – 2 bits when higher layer parameter *dmrs-tableAlt* is not configured or is set to 0, 4 bits when higher layer parameter *k-max* is set to 1 and *dmrs-tableAlt* =1, 6 bits when *k-max* is set to 3 and *dmrs-tableAlt* =1. For the 2 and 6 bit fields, two bits are defined for each interfering antenna port in Table 5.3.3.1.5C-3, where a single interfering antenna port is in {7,8} excluding the antenna port for transmission, and multiple interfering antenna ports are in {7,8,11,13} excluding the antenna ports for transmission. For the 6 bit field, the two or four LSB are reserved in the case of two or one interfering antenna port, respectively. Each pair of the used bits in 6 bit field from MSB to LSB is associated with one interfering antenna port in increasing order of port index. For the 4 bit field, two MSB are defined for interference presence and antenna port in Table 5.3.3.1.5C-4 where the single interfering antenna port is one of {7,8,11,13} excluding the antenna port for transmission, and two LSB are defined for interference modulation in 5.3.3.1.5C-5. The interfering antenna port(s) have the same scrambling identity and OCC length as indicated in the "Antenna port(s), scrambling identity and number of layers" field.

- SRS timing offset – 3 bits as defined in [3]. This field is present only when the DCI format is used for scheduling PDSCH in a LAA SCell and the UE is configured with uplink transmission on the LAA SCell.

- Aperiodic zero-power CSI-RS resource indicator for PDSCH RE Mapping – 2 bits as defined in clauses 7.1.9 and 7.2.7 of [3]. This field is present only when the UE is configured with *csi-RS-ConfigZP-ApList*.

If both transport blocks are enabled; transport block 1 is mapped to codeword 0; and transport block 2 is mapped to codeword 1. When higher layer parameter *semiOpenLoop* is configured, antenna ports 7 and 8 are used for spatial multiplexing.

In case one of the transport blocks is disabled; the transport block to codeword mapping is specified according to Table 5.3.3.1.5‑2. For the single enabled codeword, Value = 4, 5, 6 in Table 5.3.3.1.5C-1 or Value = 12, 13,14 in Table 5.3.3.1.5C-2 are only supported for retransmission of the corresponding transport block if that transport block has previously been transmitted using two, three or four layers, respectively. When higher layer parameter *semiOpenLoop* is configured, antenna ports 7 and 8 are used for transmit diversity.

If the number of information bits in format 2D carried by PDCCH belongs to one of the sizes in Table 5.3.3.1.2-1, one zero bit shall be appended to format 2D.

Table 5.3.3.1.5D-1: Antenna port(s), scrambling identity and number of layers indication

|  |
| --- |
| **Two Codewords** |
| **Value** | **Message** |
| 0 | 2 layers, ports 7-8, *nSCID*=0 |
| 1 | 2 layers, ports 7-8, *nSCID*=1 |
| 2 | 3 layers, ports 7,9,10 |
| 3 | 4 layers, ports 7-10 |
| 4 | 5 layers, ports 7,8,9,10,12 |
| 5 | 6 layers, ports 7,8,11,9,10,12 |
| 6 | 7 layers, ports 7,8,11,9,10,12,14 |
| 7 | 8 layers, ports 7,8,11,13,9,10,12,14 |

Table 5.3.3.1.5D-2: Antenna port(s), scrambling identity and number of layers indication

|  |
| --- |
| **Two Codewords**  |
| **Value** | **Message** |
| 0 | 2 layer, port 7-8, *nSCID*=0 (OCC=2) |
| 1 | 2 layer, port 7-8, *nSCID*=1 (OCC=2) |
| 2 | 2 layer, port 7-8, *nSCID*=0 (OCC=4) |
| 3 | 2 layer, port 7-8, *nSCID*=1 (OCC=4) |
| 4 |  2 layer, port 11,13, *nSCID*=0 (OCC=4) |
| 5 | 2 layer, port 11,13, *nSCID*=1 (OCC=4) |
| 6 | 3 layers, ports 7,9,10 |
| 7 | 4 layers, ports 7-10 |
| 8 | 5 layers, ports 7,8,9,10,12 |
| 9 | 6 layers, ports 7,8,11,9,10,12 |
| 10 | 7 layers, ports 7,8,11,9,10,12,14 |
| 11 | 8 layers, ports 7,8,11,13,9,10,12,14 |
| 12 | Reserved |
| 13 | Reserved |
| 14 | Reserved |
| 15 | Reserved |

\*\* unchanged parts skipped \*\*

##### 5.3.3.1.8 Format 4

DCI format 4 is used for the scheduling of PUSCH in one UL cell with multi-antenna port transmission mode,

The following information is transmitted by means of the DCI format 4:

- Carrier indicator – 0 or 3 bits. The field is present according to the definitions in [3].

- Resource block assignment -  bits, where *P* is the UL RBG size as defined in clause 8.1.2 of [3]

- For resource allocation type 0:

- The LSBs provide the resource allocation in the UL subframe as defined in clause 8.1.1 of [3]

- For resource allocation type 1:

- The  LSBs provide the resource allocation in the UL subframe as defined in clause 8.1.2 of [3]

- TPC command for scheduled PUSCH – 2 bits as defined in clause 5.1.1.1 of [3]

- Cyclic shift for DM RS and OCC index and IFDMA configuration – 3 bits as defined in clause 5.5.2.1.1 of [2]

- UL index – 2 bits as defined in clauses 5.1.1.1, 7.2.1, 8 and 8.4 of [3] (this field is present only for TDD operation with uplink-downlink configuration 0, or TDD operation with uplink-downlink configuration 6 and special subframe configuration 10 when the higher layer parameter *symPUSCH-UpPts* or *shortProcessingTime* is configured for the cell)

- Downlink Assignment Index (DAI) – 2 bits as defined in clause 7.3 of [3] (this field is present only for the following cases: 1) TDD primary cell and either TDD operation with uplink-downlink configurations 1-6 or FDD operation; or 2) EN-DC/NE-DC with FDD primary cell and higher layer parameter *tdm-PatternConfig/tdm-PatternConfigNE-DC* configured)

- CSI request – 1, 2, 3, 4 or 5 bits as defined in clause 7.2.1 of [3].

If UEs are not configured with CSI-RS-ConfigNZPAperiodic or if UEs are configured with CSI-RS-ConfigNZPAperiodic and numberActivatedAperiodicCSI-RS-Resources=1 for each CSI process,

the 2-bit field applies to UEs configured with no more than five DL cells and to

- UEs that are configured with more than one DL cell;

- UEs that are configured by higher layers with more than one CSI process;

- UEs that are configured with two CSI measurement sets by higher layers with the parameter *csi-MeasSubframeSet*;

the 3-bit field applies to UEs that are configured with more than five DL cells;

otherwise the 1-bit field applies

If UEs are configured with CSI-RS-ConfigNZPAperiodic and numberActivatedAperiodicCSI-RS-Resources>1 for at least one CSI process,

the 4-bit field applies to UEs configured with no more than five DL cells and to

- UEs that are configured with more than one DL cell;

- UEs that are configured by higher layers with more than one CSI process;

- UEs that are configured with two CSI measurement sets by higher layers with the parameter *csi-MeasSubframeSet*;

the 5-bit field applies to UEs that are configured with more than five DL cells;

otherwise the 3-bit field applies.

- SRS request – 2 bits as defined in clause 8.2 of [3]

- Resource allocation type – 1 bit as defined in clause 8.1 of [3]

- Cyclic Shift Field mapping table for DMRS – 1 bit as defined in clause 5.5.2.1.1 of [2]. The 1-bit field applies to UEs that are configured with higher layer parameter *UL-DMRS-IFDMA*.

- HARQ process number – 4 bits if higher layer parameter *ul-STTI-Length* is configured for the cell, otherwise 3 bits (this field is present when higher layer parameter *shortProcessingTime* is configured for the cell)

- Redundancy version – 2 bits (this field is present when higher layer parameter *shortProcessingTime* is configured for the cell)

In addition, for transport block 1:

- Modulation and coding scheme and redundancy version – 5 bits as defined in clause 8.6 of [3]

- New data indicator – 1 bit

In addition, for transport block 2:

- Modulation and coding scheme and redundancy version – 5 bits as defined in clause 8.6 of [3]

- New data indicator – 1 bit

Precoding information and number of layers: number of bits as specified in Table 5.3.3.1.8-1. Bit field as shown in Table 5.3.3.1.8-2 and Table 5.3.3.1.8- 3. Note that TPMI for 2 antenna ports indicates which codebook index is to be used in Table 5.3.3A.2-1 of [2], and TPMI for 4 antenna ports indicates which codebook index is to be used in Table 5.3.3A.2-2, Table 5.3.3A.2-3, Table 5.3.3A.2-4 and Table 5.3.3A.2-5 of [2]. If both transport blocks are enabled, transport block 1 is mapped to codeword 0; and transport block 2 is mapped to codeword 1. In case one of the transport blocks is disabled, the transport block to codeword mapping is specified according to Table 5.3.3.1.5-2. For a single enabled codeword, indices 24 to 39 in Table 5.3.3.1.8-3 are only supported for retransmission of the corresponding transport block if that transport block has previously been transmitted using two layers.

Table 5.3.3.1.8-1: Number of bits for precoding information

|  |  |
| --- | --- |
| Number of antenna ports at UE | Number of bits for precoding information |
| 2 | 3 |
| 4 | 6 |

Table 5.3.3.1.8-2: Content of precoding information field for 2 antenna ports

|  |  |
| --- | --- |
| One codeword: Codeword 0 enabledCodeword 1 disabled | Two codewords: Codeword 0 enabledCodeword 1 enabled |
| **Bit field mapped to index** | **Message** | **Bit field mapped to index** | **Message** |
| 0 | 1 layer: TPMI=0 | 0 | 2 layers: TPMI=0 |
| 1 | 1 layer: TPMI=1 | 1-7 | reserved |
| 2 | 1 layer: TPMI=2 |  |  |
| … | … |  |  |
| 5 | 1 layer: TPMI=5 |  |  |
| 6-7 | reserved |  |  |

Table 5.3.3.1.8-3: Content of precoding information field for 4 antenna ports

|  |  |
| --- | --- |
| One codeword: Codeword 0 enabledCodeword 1 disabled | Two codewords: Codeword 0 enabledCodeword 1 enabled |
| **Bit field mapped to index** | **Message** | **Bit field mapped to index** | **Message** |
| 0 | 1 layer: TPMI=0 | 0 | 2 layers: TPMI=0 |
| 1 | 1 layer: TPMI=1 | 1 | 2 layers: TPMI=1 |
| … | … | … | … |
| 23 | 1 layer: TPMI=23 | 15 | 2 layers: TPMI=15 |
| 24 | 2 layers: TPMI=0 | 16 | 3 layers: TPMI=0 |
| 25 | 2 layers: TPMI=1 | 17 | 3 layers: TPMI=1 |
| … | … | … | … |
| 39 | 2 layers: TPMI=15 | 27 | 3 layers: TPMI=11 |
| 40-63 | reserved | 28 | 4 layers: TPMI=0 |
|  |  | 29 - 63 | Reserved |

If the number of information bits in format 4 is equal to the payload size for DCI format 1, 2, 2A, 2B, 2C or 2D associated with the configured DL transmission mode in the same serving cell, one zero bit shall be appended to format 4.