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Multiplexing and channel coding  
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# Contents

|                                                                     |    |
|---------------------------------------------------------------------|----|
| Intellectual Property Rights .....                                  | 2  |
| Legal Notice .....                                                  | 2  |
| Modal verbs terminology.....                                        | 2  |
| Foreword.....                                                       | 6  |
| 1 Scope .....                                                       | 7  |
| 2 References .....                                                  | 7  |
| 3 Definitions, symbols and abbreviations .....                      | 7  |
| 3.1 Definitions .....                                               | 7  |
| 3.2 Symbols.....                                                    | 7  |
| 3.3 Abbreviations .....                                             | 8  |
| 4 Mapping to physical channels .....                                | 9  |
| 4.1 Uplink.....                                                     | 9  |
| 4.2 Downlink.....                                                   | 9  |
| 4.3 Sidelink .....                                                  | 9  |
| 5 General procedures.....                                           | 10 |
| 5.1 CRC calculation .....                                           | 10 |
| 5.2 Code block segmentation and code block CRC attachment .....     | 10 |
| 5.2.1 Polar coding .....                                            | 10 |
| 5.2.2 Low density parity check coding .....                         | 11 |
| 5.3 Channel coding.....                                             | 13 |
| 5.3.1 Polar coding.....                                             | 13 |
| 5.3.1.1 Interleaving .....                                          | 14 |
| 5.3.1.2 Polar encoding.....                                         | 15 |
| 5.3.2 Low density parity check coding .....                         | 19 |
| 5.3.3 Channel coding of small block lengths .....                   | 26 |
| 5.3.3.1 Encoding of 1-bit information.....                          | 26 |
| 5.3.3.2 Encoding of 2-bit information.....                          | 26 |
| 5.3.3.3 Encoding of other small block lengths .....                 | 27 |
| 5.4 Rate matching.....                                              | 27 |
| 5.4.1 Rate matching for Polar code.....                             | 27 |
| 5.4.1.1 Sub-block interleaving .....                                | 27 |
| 5.4.1.2 Bit selection.....                                          | 29 |
| 5.4.1.3 Interleaving of coded bits.....                             | 29 |
| 5.4.2 Rate matching for LDPC code.....                              | 30 |
| 5.4.2.1 Bit selection.....                                          | 30 |
| 5.4.2.2 Bit interleaving.....                                       | 33 |
| 5.4.3 Rate matching for channel coding of small block lengths ..... | 34 |
| 5.5 Code block concatenation .....                                  | 34 |
| 6 Uplink transport channels and control information.....            | 34 |
| 6.1 Random access channel.....                                      | 34 |
| 6.2 Uplink shared channel .....                                     | 35 |
| 6.2.1 Transport block CRC attachment.....                           | 35 |
| 6.2.2 LDPC base graph selection.....                                | 35 |
| 6.2.3 Code block segmentation and code block CRC attachment .....   | 35 |
| 6.2.4 Channel coding of UL-SCH.....                                 | 35 |
| 6.2.5 Rate matching .....                                           | 36 |
| 6.2.6 Code block concatenation .....                                | 36 |
| 6.2.7 Data and control multiplexing .....                           | 36 |
| 6.3 Uplink control information.....                                 | 48 |
| 6.3.1 Uplink control information on PUCCH.....                      | 48 |
| 6.3.1.1 UCI bit sequence generation .....                           | 48 |
| 6.3.1.1.1 HARQ-ACK/SR only .....                                    | 48 |

|             |                                                                                           |     |
|-------------|-------------------------------------------------------------------------------------------|-----|
| 6.3.1.1.2   | CSI only.....                                                                             | 48  |
| 6.3.1.1.3   | HARQ-ACK/SR and CSI .....                                                                 | 65  |
| 6.3.1.1.4   | UCI with different priority indexes .....                                                 | 66  |
| 6.3.1.2     | Code block segmentation and CRC attachment .....                                          | 66  |
| 6.3.1.2.1   | UCI encoded by Polar code.....                                                            | 66  |
| 6.3.1.2.2   | UCI encoded by channel coding of small block lengths.....                                 | 67  |
| 6.3.1.3     | Channel coding of UCI .....                                                               | 67  |
| 6.3.1.3.1   | UCI encoded by Polar code.....                                                            | 67  |
| 6.3.1.3.2   | UCI encoded by channel coding of small block lengths.....                                 | 67  |
| 6.3.1.4     | Rate matching .....                                                                       | 67  |
| 6.3.1.4.1   | UCI encoded by Polar code.....                                                            | 68  |
| 6.3.1.4.2   | UCI encoded by channel coding of small block lengths.....                                 | 68  |
| 6.3.1.4.3   | UCI with different priority indexes encoded by Polar code .....                           | 69  |
| 6.3.1.4.4   | UCI with different priority indexes encoded by channel coding of small block lengths..... | 69  |
| 6.3.1.5     | Code block concatenation .....                                                            | 70  |
| 6.3.1.6     | Multiplexing of coded UCI bits to PUCCH .....                                             | 70  |
| 6.3.2       | Uplink control information on PUSCH .....                                                 | 72  |
| 6.3.2.1     | UCI bit sequence generation .....                                                         | 73  |
| 6.3.2.1.1   | HARQ-ACK.....                                                                             | 73  |
| 6.3.2.1.2   | CSI.....                                                                                  | 73  |
| 6.3.2.1.3   | CG-UCI .....                                                                              | 87  |
| 6.3.2.1.4   | HARQ-ACK and CG-UCI.....                                                                  | 88  |
| 6.3.2.1.5   | UCI with different priority indexes .....                                                 | 88  |
| 6.3.2.2     | Code block segmentation and CRC attachment .....                                          | 90  |
| 6.3.2.2.1   | UCI encoded by Polar code.....                                                            | 90  |
| 6.3.2.2.2   | UCI encoded by channel coding of small block lengths.....                                 | 90  |
| 6.3.2.3     | Channel coding of UCI .....                                                               | 91  |
| 6.3.2.3.1   | UCI encoded by Polar code.....                                                            | 91  |
| 6.3.2.3.2   | UCI encoded by channel coding of small block lengths.....                                 | 91  |
| 6.3.2.4     | Rate matching .....                                                                       | 91  |
| 6.3.2.4.1   | UCI encoded by Polar code.....                                                            | 91  |
| 6.3.2.4.1.1 | HARQ-ACK .....                                                                            | 91  |
| 6.3.2.4.1.2 | CSI part 1.....                                                                           | 94  |
| 6.3.2.4.1.3 | CSI part 2.....                                                                           | 98  |
| 6.3.2.4.1.4 | CG-UCI.....                                                                               | 101 |
| 6.3.2.4.1.5 | HARQ-ACK and CG-UCI.....                                                                  | 102 |
| 6.3.2.4.1.6 | UCI with different priority indexes.....                                                  | 103 |
| 6.3.2.4.2   | UCI encoded by channel coding of small block lengths.....                                 | 105 |
| 6.3.2.4.2.1 | HARQ-ACK .....                                                                            | 105 |
| 6.3.2.4.2.2 | CSI part 1.....                                                                           | 105 |
| 6.3.2.4.2.3 | CSI part 2.....                                                                           | 106 |
| 6.3.2.4.2.4 | CG-UCI.....                                                                               | 106 |
| 6.3.2.4.2.5 | HARQ-ACK and CG-UCI.....                                                                  | 106 |
| 6.3.2.4.2.6 | UCI with different priority indexes.....                                                  | 106 |
| 6.3.2.5     | Code block concatenation .....                                                            | 108 |
| 6.3.2.6     | Multiplexing of coded UCI bits to PUSCH.....                                              | 108 |
| 6.3.2.7     | Multiplexing of coded UCI bits with different priority indexes to PUSCH.....              | 108 |
| 7           | Downlink transport channels and control information.....                                  | 109 |
| 7.1         | Broadcast channel.....                                                                    | 109 |
| 7.1.1       | PBCH payload generation .....                                                             | 109 |
| 7.1.2       | Scrambling.....                                                                           | 110 |
| 7.1.3       | Transport block CRC attachment.....                                                       | 111 |
| 7.1.4       | Channel coding .....                                                                      | 111 |
| 7.1.5       | Rate matching .....                                                                       | 111 |
| 7.2         | Downlink shared channel and paging channel .....                                          | 112 |
| 7.2.1       | Transport block CRC attachment.....                                                       | 112 |
| 7.2.2       | LDPC base graph selection.....                                                            | 112 |
| 7.2.3       | Code block segmentation and code block CRC attachment .....                               | 112 |
| 7.2.4       | Channel coding .....                                                                      | 112 |
| 7.2.5       | Rate matching .....                                                                       | 113 |
| 7.2.6       | Code block concatenation.....                                                             | 113 |

|                                       |                                                                     |            |
|---------------------------------------|---------------------------------------------------------------------|------------|
| 7.3                                   | Downlink control information .....                                  | 113        |
| 7.3.1                                 | DCI formats .....                                                   | 113        |
| 7.3.1.0                               | DCI size alignment.....                                             | 114        |
| 7.3.1.0.1                             | DCI size alignment for DCI formats for scheduling of sidelink.....  | 117        |
| 7.3.1.1                               | DCI formats for scheduling of PUSCH.....                            | 118        |
| 7.3.1.1.1                             | Format 0_0 .....                                                    | 118        |
| 7.3.1.1.2                             | Format 0_1 .....                                                    | 121        |
| 7.3.1.1.3                             | Format 0_2 .....                                                    | 150        |
| 7.3.1.2                               | DCI formats for scheduling of PDSCH.....                            | 160        |
| 7.3.1.2.1                             | Format 1_0 .....                                                    | 160        |
| 7.3.1.2.2                             | Format 1_1 .....                                                    | 163        |
| 7.3.1.2.3                             | Format 1_2 .....                                                    | 180        |
| 7.3.1.3                               | DCI formats for other purposes.....                                 | 185        |
| 7.3.1.3.1                             | Format 2_0 .....                                                    | 185        |
| 7.3.1.3.2                             | Format 2_1 .....                                                    | 186        |
| 7.3.1.3.3                             | Format 2_2 .....                                                    | 186        |
| 7.3.1.3.4                             | Format 2_3 .....                                                    | 187        |
| 7.3.1.3.5                             | Format 2_4 .....                                                    | 187        |
| 7.3.1.3.6                             | Format 2_5 .....                                                    | 187        |
| 7.3.1.3.7                             | Format 2_6 .....                                                    | 187        |
| 7.3.1.3.8                             | Format 2_7 .....                                                    | 188        |
| 7.3.1.4                               | DCI formats for scheduling of sidelink.....                         | 188        |
| 7.3.1.4.1                             | Format 3_0 .....                                                    | 188        |
| 7.3.1.4.2                             | Format 3_1 .....                                                    | 189        |
| 7.3.1.5                               | DCI formats for scheduling of MBS .....                             | 190        |
| 7.3.1.5.1                             | Format 4_0 .....                                                    | 190        |
| 7.3.1.5.2                             | Format 4_1 .....                                                    | 190        |
| 7.3.1.5.3                             | Format 4_2 .....                                                    | 191        |
| 7.3.2                                 | CRC attachment.....                                                 | 192        |
| 7.3.3                                 | Channel coding .....                                                | 193        |
| 7.3.4                                 | Rate matching .....                                                 | 193        |
| 8                                     | Sidelink transport channels and control information.....            | 193        |
| 8.1                                   | Sidelink broadcast channel .....                                    | 193        |
| 8.1.1                                 | (void) .....                                                        | 194        |
| 8.2                                   | Sidelink shared channel.....                                        | 194        |
| 8.2.1                                 | Data and control multiplexing .....                                 | 194        |
| 8.3                                   | Sidelink control information on PSCCH.....                          | 195        |
| 8.3.1                                 | 1 <sup>st</sup> -stage SCI formats.....                             | 195        |
| 8.3.1.1                               | SCI format 1-A.....                                                 | 195        |
| 8.3.2                                 | CRC attachment.....                                                 | 196        |
| 8.3.3                                 | Channel coding .....                                                | 197        |
| 8.3.4                                 | Rate Matching.....                                                  | 197        |
| 8.4                                   | Sidelink control information on PSSCH .....                         | 197        |
| 8.4.1                                 | 2 <sup>nd</sup> -stage SCI formats.....                             | 197        |
| 8.4.1.1                               | SCI format 2-A.....                                                 | 197        |
| 8.4.1.2                               | SCI format 2-B .....                                                | 198        |
| 8.4.1.3                               | SCI format 2-C.....                                                 | 198        |
| 8.4.2                                 | CRC attachment.....                                                 | 199        |
| 8.4.3                                 | Channel coding .....                                                | 199        |
| 8.4.4                                 | Rate Matching.....                                                  | 199        |
| 8.4.5                                 | Multiplexing of coded 2 <sup>nd</sup> -stage SCI bits to PSSCH..... | 200        |
| <b>Annex &lt;A&gt; (informative):</b> | <b>Change history.....</b>                                          | <b>201</b> |
| History .....                         |                                                                     | 207        |

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# Foreword

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# 1 Scope

The present document specifies the coding, multiplexing and mapping to physical channels for 5G NR.

---

## 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
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- |      |                                                                                                                 |
|------|-----------------------------------------------------------------------------------------------------------------|
| [1]  | 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".                                                           |
| [2]  | 3GPP TS 38.201: "NR; Physical Layer – General Description"                                                      |
| [3]  | 3GPP TS 38.202: "NR; Services provided by the physical layer"                                                   |
| [4]  | 3GPP TS 38.211: "NR; Physical channels and modulation"                                                          |
| [5]  | 3GPP TS 38.213: "NR; Physical layer procedures for control"                                                     |
| [6]  | 3GPP TS 38.214: "NR; Physical layer procedures for data"                                                        |
| [7]  | 3GPP TS 38.215: "NR; Physical layer measurements"                                                               |
| [8]  | 3GPP TS 38.321: "NR; Medium Access Control (MAC) protocol specification"                                        |
| [9]  | 3GPP TS 38.331: "NR; Radio Resource Control (RRC) protocol specification"                                       |
| [10] | 3GPP TS 38.473: "NG-RAN; F1 Application Protocol (F1AP)"                                                        |
| [11] | 3GPP TS 36.212: "Evolved Universal Terrestrial Radio Access (E-UTRA); Multiplexing and channel coding"          |
| [12] | 3GPP TS 23.287: "Architecture enhancements for 5G System (5GS) to support Vehicle-to-Everything (V2X) services" |

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## 3 Definitions, symbols and abbreviations

### 3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

### 3.2 Symbols

For the purposes of the present document, the following symbols apply:



### 3.3 Abbreviations

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

|          |                                                 |
|----------|-------------------------------------------------|
| BCH      | Broadcast channel                               |
| CBG      | Code block group                                |
| CBGTI    | Code block group transmission information       |
| CG       | Configured grant                                |
| CG-DFI   | CG downlink feedback information                |
| CG-UCI   | CG uplink control information                   |
| CORESET  | Control resource set                            |
| COT      | Channel occupancy time                          |
| CQI      | Channel quality indicator                       |
| CRC      | Cyclic redundancy check                         |
| CRI      | CSI-RS resource indicator                       |
| CSI      | Channel state information                       |
| CSI-RS   | CSI reference signal                            |
| DAI      | Downlink assignment index                       |
| DCI      | Downlink control information                    |
| DL       | Downlink                                        |
| DL-SCH   | Downlink shared channel                         |
| DMRS     | Demodulation reference signal                   |
| HARQ     | Hybrid automatic repeat request                 |
| HARQ-ACK | Hybrid automatic repeat request acknowledgement |
| LDPC     | Low density parity check                        |
| LI       | Layer indicator                                 |
| MBS      | Multicast broadcast services                    |
| MCS      | Modulation and coding scheme                    |
| OFDM     | Orthogonal frequency division multiplex         |
| PBCH     | Physical broadcast channel                      |
| PCH      | Paging channel                                  |
| PDCCH    | Physical downlink control channel               |
| PDSCH    | Physical downlink shared channel                |
| PMI      | Precoding matrix indicator                      |
| PRB      | Physical resource block                         |
| PRACH    | Physical random access channel                  |
| PSBCH    | Physical sidelink broadcast channel             |
| PSCCH    | Physical sidelink control channel               |
| PSFCH    | Physical sidelink feedback channel              |
| PSSCH    | Physical sidelink shared channel                |
| PTRS     | Phase-tracking reference signal                 |
| PUCCH    | Physical uplink control channel                 |
| PUSCH    | Physical uplink shared channel                  |
| RACH     | Random access channel                           |
| RI       | Rank indicator                                  |
| RSRP     | Reference signal received power                 |
| SCI      | Sidelink control information                    |
| SFCI     | Sidelink feedback control information           |
| SFN      | System frame number                             |
| SL       | Sidelink                                        |
| SL-BCH   | Sidelink broadcast channel                      |
| SL-SCH   | Sidelink shared channel                         |
| SR       | Scheduling request                              |
| SRS      | Sounding reference signal                       |
| SS       | Synchronisation signal                          |
| SUL      | Supplementary uplink                            |
| TPC      | Transmit power control                          |
| TrCH     | Transport channel                               |
| UCI      | Uplink control information                      |

|           |                        |
|-----------|------------------------|
| UE        | User equipment         |
| UL        | Uplink                 |
| UL-SCH    | Uplink shared channel  |
| VRB       | Virtual resource block |
| ZP CSI-RS | Zero power CSI-RS      |

## 4 Mapping to physical channels

### 4.1 Uplink

Table 4.1-1 specifies the mapping of the uplink transport channels to their corresponding physical channels. Table 4.1-2 specifies the mapping of the uplink control channel information to its corresponding physical channel.

Table 4.1-1

| TrCH   | Physical Channel |
|--------|------------------|
| UL-SCH | PUSCH            |
| RACH   | PRACH            |

Table 4.1-2

| Control information | Physical Channel |
|---------------------|------------------|
| UCI                 | PUCCH, PUSCH     |

### 4.2 Downlink

Table 4.2-1 specifies the mapping of the downlink transport channels to their corresponding physical channels. Table 4.2-2 specifies the mapping of the downlink control channel information to its corresponding physical channel.

Table 4.2-1

| TrCH   | Physical Channel |
|--------|------------------|
| DL-SCH | PDSCH            |
| BCH    | PBCH             |
| PCH    | PDSCH            |

Table 4.2-2

| Control information | Physical Channel |
|---------------------|------------------|
| DCI                 | PDCCH            |

### 4.3 Sidelink

Table 4.3-1 specifies the mapping of the sidelink transport channels to their corresponding physical channels. Table 4.3-2 specifies the mapping of the sidelink control information and sidelink feedback control information to their corresponding physical channels.

Table 4.3-1

| TrCH   | Physical Channel |
|--------|------------------|
| SL-SCH | PSSCH            |
| SL-BCH | PSBCH            |

Table 4.3-2

| Control information        | Physical Channel |
|----------------------------|------------------|
| 1 <sup>st</sup> -stage SCI | PSCCH            |
| 2 <sup>nd</sup> -stage SCI | PSSCH            |
| SFCI                       | PSFCH            |

## 5 General procedures

Data and control streams from/to MAC layer are encoded /decoded to offer transport and control services over the radio transmission link. Channel coding scheme is a combination of error detection, error correcting, rate matching, interleaving and transport channel or control information mapping onto/splitting from physical channels.

### 5.1 CRC calculation

Denote the input bits to the CRC computation by  $a_0, a_1, a_2, a_3, \dots, a_{A-1}$ , and the parity bits by  $p_0, p_1, p_2, p_3, \dots, p_{L-1}$ , where  $A$  is the size of the input sequence and  $L$  is the number of parity bits. The parity bits are generated by one of the following cyclic generator polynomials:

- $g_{\text{CRC24A}}(D) = [D^{24} + D^{23} + D^{18} + D^{17} + D^{14} + D^{11} + D^{10} + D^7 + D^6 + D^5 + D^4 + D^3 + D + 1]$  for a CRC length  $L = 24$ ;
- $g_{\text{CRC24B}}(D) = [D^{24} + D^{23} + D^6 + D^5 + D + 1]$  for a CRC length  $L = 24$ ;
- $g_{\text{CRC24C}}(D) = [D^{24} + D^{23} + D^{21} + D^{20} + D^{17} + D^{15} + D^{13} + D^{12} + D^8 + D^4 + D^2 + D + 1]$  for a CRC length  $L = 24$ ;
- $g_{\text{CRC16}}(D) = [D^{16} + D^{12} + D^5 + 1]$  for a CRC length  $L = 16$ ;
- $g_{\text{CRC11}}(D) = [D^{11} + D^{10} + D^9 + D^5 + 1]$  for a CRC length  $L = 11$ ;
- $g_{\text{CRC6}}(D) = [D^6 + D^5 + 1]$  for a CRC length  $L = 6$ .

The encoding is performed in a systematic form, which means that in GF(2), the polynomial:

$$a_0 D^{A+L-1} + a_1 D^{A+L-2} + \dots + a_{A-1} D^L + p_0 D^{L-1} + p_1 D^{L-2} + \dots + p_{L-2} D^1 + p_{L-1}$$

yields a remainder equal to 0 when divided by the corresponding CRC generator polynomial.

The bits after CRC attachment are denoted by  $b_0, b_1, b_2, b_3, \dots, b_{B-1}$ , where  $B = A + L$ . The relation between  $a_k$  and  $b_k$  is:

$$b_k = a_k \quad \text{for } k = 0, 1, 2, \dots, A-1$$

$$b_k = p_{k-A} \quad \text{for } k = A, A+1, A+2, \dots, A+L-1.$$

### 5.2 Code block segmentation and code block CRC attachment

#### 5.2.1 Polar coding

The input bit sequence to the code block segmentation is denoted by  $a_0, a_1, a_2, a_3, \dots, a_{A-1}$ , where  $A > 0$ .

if  $I_{\text{seg}} = 1$

Number of code blocks:  $C = 2$ ;

else

Number of code blocks:  $C=1$

end if

$A' = \lceil A/C \rceil \cdot C$ ;

for  $i = 0$  to  $A'-A-1$

$a'_i = 0$ ;

end for

for  $i = A'-A$  to  $A'-1$

$a'_i = a_{i-(A'-A)}$ ;

end for

$s = 0$ ;

for  $r = 0$  to  $C-1$

for  $k = 0$  to  $A'/C-1$

$c_{rk} = a'_s$ ;

$s = s + 1$ ;

end for

The sequence  $c_{r0}, c_{r1}, c_{r2}, c_{r3}, \dots, c_{r(A'/C-1)}$  is used to calculate the CRC parity bits  $p_{r0}, p_{r1}, p_{r2}, \dots, p_{r(L-1)}$  according to Clause 5.1 with a generator polynomial of length  $L$ .

for  $k = A'/C$  to  $A'/C + L - 1$

$c_{rk} = p_{r(k-A'/C)}$ ;

end for

end for

The value of  $A$  is no larger than 1706.

## 5.2.2 Low density parity check coding

The input bit sequence to the code block segmentation is denoted by  $b_0, b_1, b_2, b_3, \dots, b_{B-1}$ , where  $B > 0$ . If  $B$  is larger than the maximum code block size  $K_{cb}$ , segmentation of the input bit sequence is performed and an additional CRC sequence of  $L=24$  bits is attached to each code block.

For LDPC base graph 1, the maximum code block size is:

- $K_{cb} = 8448$ .

For LDPC base graph 2, the maximum code block size is:

- $K_{cb} = 3840$ .

Total number of code blocks  $C$  is determined by:

if  $B \leq K_{cb}$

$$L = 0$$

Number of code blocks:  $C = 1$

$$B' = B$$

else

$$L = 24$$

Number of code blocks:  $C = \lceil B / (K_{cb} - L) \rceil$ .

$$B' = B + C \cdot L$$

end if

The bits output from code block segmentation are denoted by  $c_{r0}, c_{r1}, c_{r2}, c_{r3}, \dots, c_{r(K_r-1)}$ , where  $0 \leq r < C$  is the code block number, and  $K_r = K$  is the number of bits for the code block number  $r$ .

The number of bits  $K$  in each code block is calculated as:

$$K' = B' / C ;$$

For LDPC base graph 1,

$$K_b = 22 .$$

For LDPC base graph 2,

if  $B > 640$

$$K_b = 10 ;$$

elseif  $B > 560$

$$K_b = 9 ;$$

elseif  $B > 192$

$$K_b = 8 ;$$

else

$$K_b = 6 ;$$

end if

find the minimum value of  $Z$  in all sets of lifting sizes in Table 5.3.2-1, denoted as  $Z_c$ , such that  $K_b \cdot Z_c \geq K'$ , and set  $K = 22Z_c$  for LDPC base graph 1 and  $K = 10Z_c$  for LDPC base graph 2;

The bit sequence  $c_{rk}$  is calculated as:

$$s = 0 ;$$

for  $r = 0$  to  $C - 1$

for  $k = 0$  to  $K' - L - 1$

$$c_{rk} = b_s ;$$

```

    s = s + 1;
end for
if C > 1
    The sequence  $c_{r0}, c_{r1}, c_{r2}, c_{r3}, \dots, c_{r(K'-L-1)}$  is used to calculate the CRC parity bits  $p_{r0}, p_{r1}, p_{r2}, \dots, p_{r(L-1)}$ 
    according to Clause 5.1 with the generator polynomial  $g_{\text{CRC24B}}(D)$ .

    for k = K' - L to K' - 1
         $c_{rk} = p_{r(k+L-K')}$ ;
    end for
end if
for k = K' to K - 1 -- Insertion of filler bits
     $c_{rk} = \text{< NULL >}$ ;
end for
end for

```

## 5.3 Channel coding

Usage of coding scheme for the different types of TrCH is shown in table 5.3-1. Usage of coding scheme for the different control information types is shown in table 5.3-2.

**Table 5.3-1: Usage of channel coding scheme for TrCHs**

| TrCH   | Coding scheme |
|--------|---------------|
| UL-SCH | LDPC          |
| DL-SCH |               |
| PCH    |               |
| BCH    | Polar code    |

**Table 5.3-2: Usage of channel coding scheme for control information**

| Control Information | Coding scheme |
|---------------------|---------------|
| DCI                 | Polar code    |
| UCI                 | Block code    |
|                     | Polar code    |

### 5.3.1 Polar coding

The bit sequence input for a given code block to channel coding is denoted by  $c_0, c_1, c_2, c_3, \dots, c_{K-1}$ , where  $K$  is the number of bits to encode. After encoding the bits are denoted by  $d_0, d_1, d_2, \dots, d_{N-1}$ , where  $N = 2^n$  and the value of  $n$  is determined by the following:

Denote by  $E$  the rate matching output sequence length as given in Clause 5.4.1;

If  $E \leq (9/8) \cdot 2^{\lceil \log_2 E \rceil - 1}$  and  $K/E < 9/16$

$$n_1 = \lceil \log_2 E \rceil - 1;$$

else

$$n_1 = \lceil \log_2 E \rceil;$$

end if

$$R_{\min} = 1/8;$$

$$n_2 = \lceil \log_2 (K / R_{\min}) \rceil;$$

$$n = \max\{\min\{n_1, n_2, n_{\max}\}, n_{\min}\}$$

where  $n_{\min} = 5$ .

UE is not expected to be configured with  $K + n_{PC} > E$ , where  $n_{PC}$  is the number of parity check bits defined in Clause 5.3.1.2.

### 5.3.1.1 Interleaving

The bit sequence  $c_0, c_1, c_2, c_3, \dots, c_{K-1}$  is interleaved into bit sequence  $c'_0, c'_1, c'_2, c'_3, \dots, c'_{K-1}$  as follows:

$$c'_k = c_{\Pi(k)}, \quad k = 0, 1, \dots, K-1$$

where the interleaving pattern  $\Pi(k)$  is given by the following:

if  $I_{IL} = 0$

$$\Pi(k) = k, \quad k = 0, 1, \dots, K-1$$

else

$$k = 0;$$

for  $m = 0$  to  $K_{IL}^{\max} - 1$

if  $\Pi_{IL}^{\max}(m) \geq K_{IL}^{\max} - K$

$$\Pi(k) = \Pi_{IL}^{\max}(m) - (K_{IL}^{\max} - K);$$

$$k = k + 1;$$

end if

end for

end if

where  $\Pi_{IL}^{\max}(m)$  is given by Table 5.3.1.1-1 and  $K_{IL}^{\max} = 164$ .

**Table 5.3.1.1-1: Interleaving pattern  $\Pi_{IL}^{\max}(m)$** 

| $m$ | $\Pi_{IL}^{\max}(m)$ | $m$ | $\Pi_{IL}^{\max}(m)$ | $m$ | $\Pi_{IL}^{\max}(m)$ | $m$ | $\Pi_{IL}^{\max}(m)$ | $m$ | $\Pi_{IL}^{\max}(m)$ | $m$ | $\Pi_{IL}^{\max}(m)$ |
|-----|----------------------|-----|----------------------|-----|----------------------|-----|----------------------|-----|----------------------|-----|----------------------|
| 0   | 0                    | 28  | 67                   | 56  | 122                  | 84  | 68                   | 112 | 33                   | 140 | 38                   |
| 1   | 2                    | 29  | 69                   | 57  | 123                  | 85  | 73                   | 113 | 36                   | 141 | 144                  |
| 2   | 4                    | 30  | 70                   | 58  | 126                  | 86  | 78                   | 114 | 44                   | 142 | 39                   |
| 3   | 7                    | 31  | 71                   | 59  | 127                  | 87  | 84                   | 115 | 47                   | 143 | 145                  |
| 4   | 9                    | 32  | 72                   | 60  | 129                  | 88  | 90                   | 116 | 64                   | 144 | 40                   |
| 5   | 14                   | 33  | 76                   | 61  | 132                  | 89  | 92                   | 117 | 74                   | 145 | 146                  |
| 6   | 19                   | 34  | 77                   | 62  | 134                  | 90  | 94                   | 118 | 79                   | 146 | 41                   |
| 7   | 20                   | 35  | 81                   | 63  | 138                  | 91  | 96                   | 119 | 85                   | 147 | 147                  |
| 8   | 24                   | 36  | 82                   | 64  | 139                  | 92  | 99                   | 120 | 97                   | 148 | 148                  |
| 9   | 25                   | 37  | 83                   | 65  | 140                  | 93  | 102                  | 121 | 100                  | 149 | 149                  |
| 10  | 26                   | 38  | 87                   | 66  | 1                    | 94  | 105                  | 122 | 103                  | 150 | 150                  |
| 11  | 28                   | 39  | 88                   | 67  | 3                    | 95  | 107                  | 123 | 117                  | 151 | 151                  |
| 12  | 31                   | 40  | 89                   | 68  | 5                    | 96  | 109                  | 124 | 125                  | 152 | 152                  |
| 13  | 34                   | 41  | 91                   | 69  | 8                    | 97  | 112                  | 125 | 131                  | 153 | 153                  |
| 14  | 42                   | 42  | 93                   | 70  | 10                   | 98  | 114                  | 126 | 136                  | 154 | 154                  |
| 15  | 45                   | 43  | 95                   | 71  | 15                   | 99  | 116                  | 127 | 142                  | 155 | 155                  |
| 16  | 49                   | 44  | 98                   | 72  | 21                   | 100 | 121                  | 128 | 12                   | 156 | 156                  |
| 17  | 50                   | 45  | 101                  | 73  | 27                   | 101 | 124                  | 129 | 17                   | 157 | 157                  |
| 18  | 51                   | 46  | 104                  | 74  | 29                   | 102 | 128                  | 130 | 23                   | 158 | 158                  |
| 19  | 53                   | 47  | 106                  | 75  | 32                   | 103 | 130                  | 131 | 37                   | 159 | 159                  |
| 20  | 54                   | 48  | 108                  | 76  | 35                   | 104 | 133                  | 132 | 48                   | 160 | 160                  |
| 21  | 56                   | 49  | 110                  | 77  | 43                   | 105 | 135                  | 133 | 75                   | 161 | 161                  |
| 22  | 58                   | 50  | 111                  | 78  | 46                   | 106 | 141                  | 134 | 80                   | 162 | 162                  |
| 23  | 59                   | 51  | 113                  | 79  | 52                   | 107 | 6                    | 135 | 86                   | 163 | 163                  |
| 24  | 61                   | 52  | 115                  | 80  | 55                   | 108 | 11                   | 136 | 137                  |     |                      |
| 25  | 62                   | 53  | 118                  | 81  | 57                   | 109 | 16                   | 137 | 143                  |     |                      |
| 26  | 65                   | 54  | 119                  | 82  | 60                   | 110 | 22                   | 138 | 13                   |     |                      |
| 27  | 66                   | 55  | 120                  | 83  | 63                   | 111 | 30                   | 139 | 18                   |     |                      |

### 5.3.1.2 Polar encoding

The Polar sequence  $\mathbf{Q}_0^{N_{\max}-1} = \{Q_0^{N_{\max}}, Q_1^{N_{\max}}, \dots, Q_{N_{\max}-1}^{N_{\max}}\}$  is given by Table 5.3.1.2-1, where  $0 \leq Q_i^{N_{\max}} \leq N_{\max} - 1$  denotes a bit index before Polar encoding for  $i = 0, 1, \dots, N_{\max} - 1$  and  $N_{\max} = 1024$ . The Polar sequence  $\mathbf{Q}_0^{N_{\max}-1}$  is in ascending order of reliability  $w(Q_0^{N_{\max}}) < w(Q_1^{N_{\max}}) < \dots < w(Q_{N_{\max}-1}^{N_{\max}})$ , where  $w(Q_i^{N_{\max}})$  denotes the reliability of bit index  $Q_i^{N_{\max}}$ .

For any code block encoded to  $N$  bits, a same Polar sequence  $\mathbf{Q}_0^{N-1} = \{Q_0^N, Q_1^N, Q_2^N, \dots, Q_{N-1}^N\}$  is used. The Polar sequence  $\mathbf{Q}_0^{N-1}$  is a subset of Polar sequence  $\mathbf{Q}_0^{N_{\max}-1}$  with all elements  $Q_i^{N_{\max}}$  of values less than  $N$ , ordered in ascending order of reliability  $w(Q_0^N) < w(Q_1^N) < w(Q_2^N) < \dots < w(Q_{N-1}^N)$ .

Denote  $\overline{\mathbf{Q}}_I^N$  as a set of bit indices in Polar sequence  $\mathbf{Q}_0^{N-1}$ , and  $\overline{\mathbf{Q}}_F^N$  as the set of other bit indices in Polar sequence  $\mathbf{Q}_0^{N-1}$ , where  $\overline{\mathbf{Q}}_I^N$  and  $\overline{\mathbf{Q}}_F^N$  are given in Clause 5.4.1.1,  $|\overline{\mathbf{Q}}_I^N| = K + n_{PC}$ ,  $|\overline{\mathbf{Q}}_F^N| = N - |\overline{\mathbf{Q}}_I^N|$ , and  $n_{PC}$  is the number of parity check bits.

Denote  $\mathbf{G}_N = (\mathbf{G}_2)^{\otimes n}$  as the  $n$ -th Kronecker power of matrix  $\mathbf{G}_2$ , where  $\mathbf{G}_2 = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}$ .

For a bit index  $j$  with  $j = 0, 1, \dots, N - 1$ , denote  $\mathbf{g}_j$  as the  $j$ -th row of  $\mathbf{G}_N$  and  $w(\mathbf{g}_j)$  as the row weight of  $\mathbf{g}_j$ , where  $w(\mathbf{g}_j)$  is the number of ones in  $\mathbf{g}_j$ . Denote the set of bit indices for parity check bits as  $\mathbf{Q}_{PC}^N$ , where  $|\mathbf{Q}_{PC}^N| = n_{PC}$ . A number of  $(n_{PC} - n_{PC}^{wm})$  parity check bits are placed in the  $(n_{PC} - n_{PC}^{wm})$  least reliable bit indices in  $\overline{\mathbf{Q}}_I^N$ . A number of  $n_{PC}^{wm}$  other parity check bits are placed in the bit indices of minimum row weight in  $\tilde{\mathbf{Q}}_I^N$ , where  $\tilde{\mathbf{Q}}_I^N$  denotes the  $(|\overline{\mathbf{Q}}_I^N| - n_{PC})$  most reliable bit indices in  $\overline{\mathbf{Q}}_I^N$ ; if there are more than  $n_{PC}^{wm}$  bit indices of the same minimum row weight in  $\tilde{\mathbf{Q}}_I^N$ , the  $n_{PC}^{wm}$  other parity check bits are placed in the  $n_{PC}^{wm}$  bit indices of the highest reliability and the minimum row weight in  $\tilde{\mathbf{Q}}_I^N$ .

Generate  $\mathbf{u} = [u_0 \ u_1 \ u_2 \ \dots \ u_{N-1}]$  according to the following:

$$k = 0;$$



if  $n_{PC} > 0$

$y_0 = 0; y_1 = 0; y_2 = 0; y_3 = 0; y_4 = 0;$

for  $n = 0$  to  $N - 1$

$y_t = y_0; y_0 = y_1; y_1 = y_2; y_2 = y_3; y_3 = y_4; y_4 = y_t;$

if  $n \in \overline{\mathbf{Q}}_I^N$

if  $n \in \mathbf{Q}_{PC}^N$

$u_n = y_0;$

else

$u_n = c_k';$

$k = k + 1;$

$y_0 = y_0 \oplus u_n;$

end if

else

$u_n = 0;$

end if

end for

else

for  $n = 0$  to  $N - 1$

if  $n \in \overline{\mathbf{Q}}_I^N$

$u_n = c_k';$

$k = k + 1;$

else

$u_n = 0;$

end if

end for

end if

The output after encoding  $\mathbf{d} = [d_0 \ d_1 \ d_2 \ \dots \ d_{N-1}]$  is obtained by  $\mathbf{d} = \mathbf{u}\mathbf{G}_N$ . The encoding is performed in GF(2).

Table 5.3.1.2-1: Polar sequence  $Q_0^{N_{\max}-1}$  and its corresponding reliability  $W(Q_i^{N_{\max}})$

| $W(Q_i^{N_{\max}})$ | $Q_i^{N_{\max}}$ | $W(Q_i^{N_{\max}})$ | $Q_i^{N_{\max}}$ | $W(Q_i^{N_{\max}})$ | $Q_i^{N_{\max}}$ | $W(Q_i^{N_{\max}})$ | $Q_i^{N_{\max}}$ | $W(Q_i^{N_{\max}})$ | $Q_i^{N_{\max}}$ | $W(Q_i^{N_{\max}})$ | $Q_i^{N_{\max}}$ | $W(Q_i^{N_{\max}})$ | $Q_i^{N_{\max}}$ | $W(Q_i^{N_{\max}})$ | $Q_i^{N_{\max}}$ |
|---------------------|------------------|---------------------|------------------|---------------------|------------------|---------------------|------------------|---------------------|------------------|---------------------|------------------|---------------------|------------------|---------------------|------------------|
| 0                   | 0                | 128                 | 518              | 256                 | 94               | 384                 | 214              | 512                 | 364              | 640                 | 414              | 768                 | 819              | 896                 | 966              |
| 1                   | 1                | 129                 | 54               | 257                 | 204              | 385                 | 309              | 513                 | 654              | 641                 | 223              | 769                 | 814              | 897                 | 755              |
| 2                   | 2                | 130                 | 83               | 258                 | 298              | 386                 | 188              | 514                 | 659              | 642                 | 663              | 770                 | 439              | 898                 | 859              |
| 3                   | 4                | 131                 | 57               | 259                 | 400              | 387                 | 449              | 515                 | 335              | 643                 | 692              | 771                 | 929              | 899                 | 940              |
| 4                   | 8                | 132                 | 521              | 260                 | 608              | 388                 | 217              | 516                 | 480              | 644                 | 835              | 772                 | 490              | 900                 | 830              |
| 5                   | 16               | 133                 | 112              | 261                 | 352              | 389                 | 408              | 517                 | 315              | 645                 | 619              | 773                 | 623              | 901                 | 911              |
| 6                   | 32               | 134                 | 135              | 262                 | 325              | 390                 | 609              | 518                 | 221              | 646                 | 472              | 774                 | 671              | 902                 | 871              |
| 7                   | 3                | 135                 | 78               | 263                 | 533              | 391                 | 596              | 519                 | 370              | 647                 | 455              | 775                 | 739              | 903                 | 639              |
| 8                   | 5                | 136                 | 289              | 264                 | 155              | 392                 | 551              | 520                 | 613              | 648                 | 796              | 776                 | 916              | 904                 | 888              |
| 9                   | 64               | 137                 | 194              | 265                 | 210              | 393                 | 650              | 521                 | 422              | 649                 | 809              | 777                 | 463              | 905                 | 479              |
| 10                  | 9                | 138                 | 85               | 266                 | 305              | 394                 | 229              | 522                 | 425              | 650                 | 714              | 778                 | 843              | 906                 | 946              |
| 11                  | 6                | 139                 | 276              | 267                 | 547              | 395                 | 159              | 523                 | 451              | 651                 | 721              | 779                 | 381              | 907                 | 750              |
| 12                  | 17               | 140                 | 522              | 268                 | 300              | 396                 | 420              | 524                 | 614              | 652                 | 837              | 780                 | 497              | 908                 | 969              |
| 13                  | 10               | 141                 | 58               | 269                 | 109              | 397                 | 310              | 525                 | 543              | 653                 | 716              | 781                 | 930              | 909                 | 508              |
| 14                  | 18               | 142                 | 168              | 270                 | 184              | 398                 | 541              | 526                 | 235              | 654                 | 864              | 782                 | 821              | 910                 | 861              |
| 15                  | 128              | 143                 | 139              | 271                 | 534              | 399                 | 773              | 527                 | 412              | 655                 | 810              | 783                 | 726              | 911                 | 757              |
| 16                  | 12               | 144                 | 99               | 272                 | 537              | 400                 | 610              | 528                 | 343              | 656                 | 606              | 784                 | 961              | 912                 | 970              |
| 17                  | 33               | 145                 | 86               | 273                 | 115              | 401                 | 657              | 529                 | 372              | 657                 | 912              | 785                 | 872              | 913                 | 919              |
| 18                  | 65               | 146                 | 60               | 274                 | 167              | 402                 | 333              | 530                 | 775              | 658                 | 722              | 786                 | 492              | 914                 | 875              |
| 19                  | 20               | 147                 | 280              | 275                 | 225              | 403                 | 119              | 531                 | 317              | 659                 | 696              | 787                 | 631              | 915                 | 862              |
| 20                  | 256              | 148                 | 89               | 276                 | 326              | 404                 | 600              | 532                 | 222              | 660                 | 377              | 788                 | 729              | 916                 | 758              |
| 21                  | 34               | 149                 | 290              | 277                 | 306              | 405                 | 339              | 533                 | 426              | 661                 | 435              | 789                 | 700              | 917                 | 948              |
| 22                  | 24               | 150                 | 529              | 278                 | 772              | 406                 | 218              | 534                 | 453              | 662                 | 817              | 790                 | 443              | 918                 | 977              |
| 23                  | 36               | 151                 | 524              | 279                 | 157              | 407                 | 368              | 535                 | 237              | 663                 | 319              | 791                 | 741              | 919                 | 923              |
| 24                  | 7                | 152                 | 196              | 280                 | 656              | 408                 | 652              | 536                 | 559              | 664                 | 621              | 792                 | 845              | 920                 | 972              |
| 25                  | 129              | 153                 | 141              | 281                 | 329              | 409                 | 230              | 537                 | 833              | 665                 | 812              | 793                 | 920              | 921                 | 761              |
| 26                  | 66               | 154                 | 101              | 282                 | 110              | 410                 | 391              | 538                 | 804              | 666                 | 484              | 794                 | 382              | 922                 | 877              |
| 27                  | 512              | 155                 | 147              | 283                 | 117              | 411                 | 313              | 539                 | 712              | 667                 | 430              | 795                 | 822              | 923                 | 952              |
| 28                  | 11               | 156                 | 176              | 284                 | 212              | 412                 | 450              | 540                 | 834              | 668                 | 838              | 796                 | 851              | 924                 | 495              |
| 29                  | 40               | 157                 | 142              | 285                 | 171              | 413                 | 542              | 541                 | 661              | 669                 | 667              | 797                 | 730              | 925                 | 703              |
| 30                  | 68               | 158                 | 530              | 286                 | 776              | 414                 | 334              | 542                 | 808              | 670                 | 488              | 798                 | 498              | 926                 | 935              |
| 31                  | 130              | 159                 | 321              | 287                 | 330              | 415                 | 233              | 543                 | 779              | 671                 | 239              | 799                 | 880              | 927                 | 978              |
| 32                  | 19               | 160                 | 31               | 288                 | 226              | 416                 | 555              | 544                 | 617              | 672                 | 378              | 800                 | 742              | 928                 | 883              |
| 33                  | 13               | 161                 | 200              | 289                 | 549              | 417                 | 774              | 545                 | 604              | 673                 | 459              | 801                 | 445              | 929                 | 762              |
| 34                  | 48               | 162                 | 90               | 290                 | 538              | 418                 | 175              | 546                 | 433              | 674                 | 622              | 802                 | 471              | 930                 | 503              |
| 35                  | 14               | 163                 | 545              | 291                 | 387              | 419                 | 123              | 547                 | 720              | 675                 | 627              | 803                 | 635              | 931                 | 925              |
| 36                  | 72               | 164                 | 292              | 292                 | 308              | 420                 | 658              | 548                 | 816              | 676                 | 437              | 804                 | 932              | 932                 | 878              |
| 37                  | 257              | 165                 | 322              | 293                 | 216              | 421                 | 612              | 549                 | 836              | 677                 | 380              | 805                 | 687              | 933                 | 735              |
| 38                  | 21               | 166                 | 532              | 294                 | 416              | 422                 | 341              | 550                 | 347              | 678                 | 818              | 806                 | 903              | 934                 | 993              |
| 39                  | 132              | 167                 | 263              | 295                 | 271              | 423                 | 777              | 551                 | 897              | 679                 | 461              | 807                 | 825              | 935                 | 885              |
| 40                  | 35               | 168                 | 149              | 296                 | 279              | 424                 | 220              | 552                 | 243              | 680                 | 496              | 808                 | 500              | 936                 | 939              |
| 41                  | 258              | 169                 | 102              | 297                 | 158              | 425                 | 314              | 553                 | 662              | 681                 | 669              | 809                 | 846              | 937                 | 994              |
| 42                  | 26               | 170                 | 105              | 298                 | 337              | 426                 | 424              | 554                 | 454              | 682                 | 679              | 810                 | 745              | 938                 | 980              |
| 43                  | 513              | 171                 | 304              | 299                 | 550              | 427                 | 395              | 555                 | 318              | 683                 | 724              | 811                 | 826              | 939                 | 926              |
| 44                  | 80               | 172                 | 296              | 300                 | 672              | 428                 | 673              | 556                 | 675              | 684                 | 841              | 812                 | 732              | 940                 | 764              |
| 45                  | 37               | 173                 | 163              | 301                 | 118              | 429                 | 583              | 557                 | 618              | 685                 | 629              | 813                 | 446              | 941                 | 941              |
| 46                  | 25               | 174                 | 92               | 302                 | 332              | 430                 | 355              | 558                 | 898              | 686                 | 351              | 814                 | 962              | 942                 | 967              |
| 47                  | 22               | 175                 | 47               | 303                 | 579              | 431                 | 287              | 559                 | 781              | 687                 | 467              | 815                 | 936              | 943                 | 886              |
| 48                  | 136              | 176                 | 267              | 304                 | 540              | 432                 | 183              | 560                 | 376              | 688                 | 438              | 816                 | 475              | 944                 | 831              |
| 49                  | 260              | 177                 | 385              | 305                 | 389              | 433                 | 234              | 561                 | 428              | 689                 | 737              | 817                 | 853              | 945                 | 947              |
| 50                  | 264              | 178                 | 546              | 306                 | 173              | 434                 | 125              | 562                 | 665              | 690                 | 251              | 818                 | 867              | 946                 | 507              |
| 51                  | 38               | 179                 | 324              | 307                 | 121              | 435                 | 557              | 563                 | 736              | 691                 | 462              | 819                 | 637              | 947                 | 889              |
| 52                  | 514              | 180                 | 208              | 308                 | 553              | 436                 | 660              | 564                 | 567              | 692                 | 442              | 820                 | 907              | 948                 | 984              |
| 53                  | 96               | 181                 | 386              | 309                 | 199              | 437                 | 616              | 565                 | 840              | 693                 | 441              | 821                 | 487              | 949                 | 751              |
| 54                  | 67               | 182                 | 150              | 310                 | 784              | 438                 | 342              | 566                 | 625              | 694                 | 469              | 822                 | 695              | 950                 | 942              |
| 55                  | 41               | 183                 | 153              | 311                 | 179              | 439                 | 316              | 567                 | 238              | 695                 | 247              | 823                 | 746              | 951                 | 996              |
| 56                  | 144              | 184                 | 165              | 312                 | 228              | 440                 | 241              | 568                 | 359              | 696                 | 683              | 824                 | 828              | 952                 | 971              |
| 57                  | 28               | 185                 | 106              | 313                 | 338              | 441                 | 778              | 569                 | 457              | 697                 | 842              | 825                 | 753              | 953                 | 890              |
| 58                  | 69               | 186                 | 55               | 314                 | 312              | 442                 | 563              | 570                 | 399              | 698                 | 738              | 826                 | 854              | 954                 | 509              |
| 59                  | 42               | 187                 | 328              | 315                 | 704              | 443                 | 345              | 571                 | 787              | 699                 | 899              | 827                 | 857              | 955                 | 949              |
| 60                  | 516              | 188                 | 536              | 316                 | 390              | 444                 | 452              | 572                 | 591              | 700                 | 670              | 828                 | 504              | 956                 | 973              |
| 61                  | 49               | 189                 | 577              | 317                 | 174              | 445                 | 397              | 573                 | 678              | 701                 | 783              | 829                 | 799              | 957                 | 1000             |
| 62                  | 74               | 190                 | 548              | 318                 | 554              | 446                 | 403              | 574                 | 434              | 702                 | 849              | 830                 | 255              | 958                 | 892              |
| 63                  | 272              | 191                 | 113              | 319                 | 581              | 447                 | 207              | 575                 | 677              | 703                 | 820              | 831                 | 964              | 959                 | 950              |
| 64                  | 160              | 192                 | 154              | 320                 | 393              | 448                 | 674              | 576                 | 349              | 704                 | 728              | 832                 | 909              | 960                 | 863              |
| 65                  | 520              | 193                 | 79               | 321                 | 283              | 449                 | 558              | 577                 | 245              | 705                 | 928              | 833                 | 719              | 961                 | 759              |
| 66                  | 288              | 194                 | 269              | 322                 | 122              | 450                 | 785              | 578                 | 458              | 706                 | 791              | 834                 | 477              | 962                 | 1008             |
| 67                  | 528              | 195                 | 108              | 323                 | 448              | 451                 | 432              | 579                 | 666              | 707                 | 367              | 835                 | 915              | 963                 | 510              |
| 68                  | 192              | 196                 | 578              | 324                 | 353              | 452                 | 357              | 580                 | 620              | 708                 | 901              | 836                 | 638              | 964                 | 979              |
| 69                  | 544              | 197                 | 224              | 325                 | 561              | 453                 | 187              | 581                 | 363              | 709                 | 630              | 837                 | 748              | 965                 | 953              |
| 70                  | 70               | 198                 | 166              | 326                 | 203              | 454                 | 236              | 582                 | 127              | 710                 | 685              | 838                 | 944              | 966                 | 763              |
| 71                  | 44               | 199                 | 519              | 327                 | 63               | 455                 | 664              | 583                 | 191              | 711                 | 844              | 839                 | 869              | 967                 | 974              |
| 72                  | 131              | 200                 | 552              | 328                 | 340              | 456                 | 624              | 584                 | 782              | 712                 | 633              | 840                 | 491              | 968                 | 954              |
| 73                  | 81               | 201                 | 195              | 329                 | 394              | 457                 | 587              | 585                 | 407              | 713                 | 711              | 841                 | 699              | 969                 | 879              |
| 74                  | 50               | 202                 | 270              | 330                 | 527              | 458                 | 780              | 586                 | 436              | 714                 | 253              | 842                 | 754              | 970                 | 981              |
| 75                  | 73               | 203                 | 641              | 331                 | 582              | 459                 | 705              | 587                 | 626              | 715                 | 691              | 843                 | 858              | 971                 | 982              |
| 76                  | 15               | 204                 | 523              | 332                 | 556              | 460                 | 126              | 588                 | 571              | 716                 | 824              | 844                 | 478              | 972                 | 927              |
| 77                  | 320              | 205                 | 275              | 333                 | 181              | 461                 | 242              | 589                 | 465              | 717                 | 902              | 845                 | 968              | 973                 | 995              |
| 78                  | 133              | 206                 | 580              | 334                 | 295              | 462                 | 565              | 590                 | 681              | 718                 | 686              | 846                 | 383              | 974                 | 765              |
| 79                  | 52               | 207                 | 291              | 335                 | 285              | 463                 | 398              | 591                 | 246              | 719                 | 740              | 847                 | 910              | 975                 | 956              |
| 80                  | 23               | 208                 | 59               | 336                 | 232              | 464                 | 346              | 592                 | 707              | 720                 | 850              | 848                 | 815              | 976                 | 887              |
| 81                  | 134              | 209                 | 169              | 337                 | 124              | 465                 | 456              | 593                 | 350              | 721                 | 375              | 849                 | 976              | 977                 | 985              |
| 82                  | 384              | 210                 | 560              | 338                 | 205              | 466                 | 358              | 594                 | 599              | 722                 | 444              | 850                 | 870              | 978                 | 997              |
| 83                  | 76               | 211                 | 114              | 339                 | 182              | 467                 | 405              | 595                 | 668              | 723                 | 470              | 851                 | 917              | 979                 | 986              |
| 84                  | 137              | 212                 | 277              | 340                 | 643              | 468                 | 303              | 596                 | 790              | 724                 | 483              | 852                 | 727              | 980                 | 943              |
| 85                  | 82               | 213                 | 156              | 341                 | 562              | 469                 | 569              | 597                 | 460              | 725                 | 415              | 853                 | 493              | 981                 | 891              |
| 86                  | 56               | 214                 | 87               | 342                 | 286              | 470                 | 244              | 598                 | 249              | 726                 | 485              | 854                 | 873              | 982                 | 998              |

|     |     |     |     |     |     |     |     |     |     |     |     |     |     |      |      |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| 87  | 27  | 215 | 197 | 343 | 585 | 471 | 595 | 599 | 682 | 727 | 905 | 855 | 701 | 983  | 766  |
| 88  | 97  | 216 | 116 | 344 | 299 | 472 | 189 | 600 | 573 | 728 | 795 | 856 | 931 | 984  | 511  |
| 89  | 39  | 217 | 170 | 345 | 354 | 473 | 566 | 601 | 411 | 729 | 473 | 857 | 756 | 985  | 988  |
| 90  | 259 | 218 | 61  | 346 | 211 | 474 | 676 | 602 | 803 | 730 | 634 | 858 | 860 | 986  | 1001 |
| 91  | 84  | 219 | 531 | 347 | 401 | 475 | 361 | 603 | 789 | 731 | 744 | 859 | 499 | 987  | 951  |
| 92  | 138 | 220 | 525 | 348 | 185 | 476 | 706 | 604 | 709 | 732 | 852 | 860 | 731 | 988  | 1002 |
| 93  | 145 | 221 | 642 | 349 | 396 | 477 | 589 | 605 | 365 | 733 | 960 | 861 | 823 | 989  | 893  |
| 94  | 261 | 222 | 281 | 350 | 344 | 478 | 215 | 606 | 440 | 734 | 865 | 862 | 922 | 990  | 975  |
| 95  | 29  | 223 | 278 | 351 | 586 | 479 | 786 | 607 | 628 | 735 | 693 | 863 | 874 | 991  | 894  |
| 96  | 43  | 224 | 526 | 352 | 645 | 480 | 647 | 608 | 689 | 736 | 797 | 864 | 918 | 992  | 1009 |
| 97  | 98  | 225 | 177 | 353 | 593 | 481 | 348 | 609 | 374 | 737 | 906 | 865 | 502 | 993  | 955  |
| 98  | 515 | 226 | 293 | 354 | 535 | 482 | 419 | 610 | 423 | 738 | 715 | 866 | 933 | 994  | 1004 |
| 99  | 88  | 227 | 388 | 355 | 240 | 483 | 406 | 611 | 466 | 739 | 807 | 867 | 743 | 995  | 1010 |
| 100 | 140 | 228 | 91  | 356 | 206 | 484 | 464 | 612 | 793 | 740 | 474 | 868 | 760 | 996  | 957  |
| 101 | 30  | 229 | 584 | 357 | 95  | 485 | 680 | 613 | 250 | 741 | 636 | 869 | 881 | 997  | 983  |
| 102 | 146 | 230 | 769 | 358 | 327 | 486 | 801 | 614 | 371 | 742 | 694 | 870 | 494 | 998  | 958  |
| 103 | 71  | 231 | 198 | 359 | 564 | 487 | 362 | 615 | 481 | 743 | 254 | 871 | 702 | 999  | 987  |
| 104 | 262 | 232 | 172 | 360 | 800 | 488 | 590 | 616 | 574 | 744 | 717 | 872 | 921 | 1000 | 1012 |
| 105 | 265 | 233 | 120 | 361 | 402 | 489 | 409 | 617 | 413 | 745 | 575 | 873 | 501 | 1001 | 999  |
| 106 | 161 | 234 | 201 | 362 | 356 | 490 | 570 | 618 | 603 | 746 | 913 | 874 | 876 | 1002 | 1016 |
| 107 | 576 | 235 | 336 | 363 | 307 | 491 | 788 | 619 | 366 | 747 | 798 | 875 | 847 | 1003 | 767  |
| 108 | 45  | 236 | 62  | 364 | 301 | 492 | 597 | 620 | 468 | 748 | 811 | 876 | 992 | 1004 | 989  |
| 109 | 100 | 237 | 282 | 365 | 417 | 493 | 572 | 621 | 655 | 749 | 379 | 877 | 447 | 1005 | 1003 |
| 110 | 640 | 238 | 143 | 366 | 213 | 494 | 219 | 622 | 900 | 750 | 697 | 878 | 733 | 1006 | 990  |
| 111 | 51  | 239 | 103 | 367 | 568 | 495 | 311 | 623 | 805 | 751 | 431 | 879 | 827 | 1007 | 1005 |
| 112 | 148 | 240 | 178 | 368 | 832 | 496 | 708 | 624 | 615 | 752 | 607 | 880 | 934 | 1008 | 959  |
| 113 | 46  | 241 | 294 | 369 | 588 | 497 | 598 | 625 | 684 | 753 | 489 | 881 | 882 | 1009 | 1011 |
| 114 | 75  | 242 | 93  | 370 | 186 | 498 | 601 | 626 | 710 | 754 | 866 | 882 | 937 | 1010 | 1013 |
| 115 | 266 | 243 | 644 | 371 | 646 | 499 | 651 | 627 | 429 | 755 | 723 | 883 | 963 | 1011 | 895  |
| 116 | 273 | 244 | 202 | 372 | 404 | 500 | 421 | 628 | 794 | 756 | 486 | 884 | 747 | 1012 | 1006 |
| 117 | 517 | 245 | 592 | 373 | 227 | 501 | 792 | 629 | 252 | 757 | 908 | 885 | 505 | 1013 | 1014 |
| 118 | 104 | 246 | 323 | 374 | 896 | 502 | 802 | 630 | 373 | 758 | 718 | 886 | 855 | 1014 | 1017 |
| 119 | 162 | 247 | 392 | 375 | 594 | 503 | 611 | 631 | 605 | 759 | 813 | 887 | 924 | 1015 | 1018 |
| 120 | 53  | 248 | 297 | 376 | 418 | 504 | 602 | 632 | 848 | 760 | 476 | 888 | 734 | 1016 | 991  |
| 121 | 193 | 249 | 770 | 377 | 302 | 505 | 410 | 633 | 690 | 761 | 856 | 889 | 829 | 1017 | 1020 |
| 122 | 152 | 250 | 107 | 378 | 649 | 506 | 231 | 634 | 713 | 762 | 839 | 890 | 965 | 1018 | 1007 |
| 123 | 77  | 251 | 180 | 379 | 771 | 507 | 688 | 635 | 632 | 763 | 725 | 891 | 938 | 1019 | 1015 |
| 124 | 164 | 252 | 151 | 380 | 360 | 508 | 653 | 636 | 482 | 764 | 698 | 892 | 884 | 1020 | 1019 |
| 125 | 768 | 253 | 209 | 381 | 539 | 509 | 248 | 637 | 806 | 765 | 914 | 893 | 506 | 1021 | 1021 |
| 126 | 268 | 254 | 284 | 382 | 111 | 510 | 369 | 638 | 427 | 766 | 752 | 894 | 749 | 1022 | 1022 |
| 127 | 274 | 255 | 648 | 383 | 331 | 511 | 190 | 639 | 904 | 767 | 868 | 895 | 945 | 1023 | 1023 |

### 5.3.2 Low density parity check coding

The bit sequence input for a given code block to channel coding is denoted by  $c_0, c_1, c_2, c_3, \dots, c_{K-1}$ , where  $K$  is the number of bits to encode as defined in Clause 5.2.2. After encoding the bits are denoted by  $d_0, d_1, d_2, \dots, d_{N-1}$ , where  $N = 66Z_c$  for LDPC base graph 1 and  $N = 50Z_c$  for LDPC base graph 2, and the value of  $Z_c$  is given in Clause 5.2.2.

For a code block encoded by LDPC, the following encoding procedure applies:

1) Find the set with index  $i_{LS}$  in Table 5.3.2-1 which contains  $Z_c$ .

2) for  $k = 2Z_c$  to  $K - 1$

if  $c_k \neq NULL$

$d_{k-2Z_c} = c_k$ ;

else

$c_k = 0$ ;

$d_{k-2Z_c} = NULL$ ;

end if

end for

3) Generate  $N + 2Z_c - K$  parity bits  $\mathbf{w} = [w_0, w_1, w_2, \dots, w_{N+2Z_c-K-1}]^T$  such that  $\mathbf{H} \times \begin{bmatrix} \mathbf{c} \\ \mathbf{w} \end{bmatrix} = \mathbf{0}$ , where

$\mathbf{c} = [c_0, c_1, c_2, \dots, c_{K-1}]^T$ ;  $\mathbf{0}$  is a column vector of all elements equal to 0. The encoding is performed in GF(2).

For LDPC base graph 1, a matrix of  $\mathbf{H}_{\text{BG}}$  has 46 rows with row indices  $i = 0, 1, 2, \dots, 45$  and 68 columns with column indices  $j = 0, 1, 2, \dots, 67$ . For LDPC base graph 2, a matrix of  $\mathbf{H}_{\text{BG}}$  has 42 rows with row indices  $i = 0, 1, 2, \dots, 41$  and 52 columns with column indices  $j = 0, 1, 2, \dots, 51$ . The elements in  $\mathbf{H}_{\text{BG}}$  with row and column indices given in Table 5.3.2-2 (for LDPC base graph 1) and Table 5.3.2-3 (for LDPC base graph 2) are of value 1, and all other elements in  $\mathbf{H}_{\text{BG}}$  are of value 0.

The matrix  $\mathbf{H}$  is obtained by replacing each element of  $\mathbf{H}_{\text{BG}}$  with a  $Z_c \times Z_c$  matrix, according to the following:

- Each element of value 0 in  $\mathbf{H}_{\text{BG}}$  is replaced by an all zero matrix  $\mathbf{0}$  of size  $Z_c \times Z_c$ ;
- Each element of value 1 in  $\mathbf{H}_{\text{BG}}$  is replaced by a circular permutation matrix  $\mathbf{I}(p_{i,j})$  of size  $Z_c \times Z_c$ , where  $i$  and  $j$  are the row and column indices of the element, and  $\mathbf{I}(p_{i,j})$  is obtained by circularly shifting the identity matrix  $\mathbf{I}$  of size  $Z_c \times Z_c$  to the right  $p_{i,j}$  times. The value of  $p_{i,j}$  is given by  $p_{i,j} = \text{mod}(V_{i,j}, Z_c)$ . The value of  $V_{i,j}$  is given by Tables 5.3.2-2 and 5.3.2-3 according to the set index  $i_{\text{LS}}$  and LDPC base graph.

4) for  $k = K$  to  $N + 2Z_c - 1$

$$d_{k-2Z_c} = w_{k-K};$$

end for

**Table 5.3.2-1: Sets of LDPC lifting size  $Z$**

| Set index ( $i_{\text{LS}}$ ) | Set of lifting sizes ( $Z$ )     |
|-------------------------------|----------------------------------|
| 0                             | {2, 4, 8, 16, 32, 64, 128, 256}  |
| 1                             | {3, 6, 12, 24, 48, 96, 192, 384} |
| 2                             | {5, 10, 20, 40, 80, 160, 320}    |
| 3                             | {7, 14, 28, 56, 112, 224}        |
| 4                             | {9, 18, 36, 72, 144, 288}        |
| 5                             | {11, 22, 44, 88, 176, 352}       |
| 6                             | {13, 26, 52, 104, 208}           |
| 7                             | {15, 30, 60, 120, 240}           |

Table 5.3.2-2: LDPC base graph 1 ( $H_{BG}$ ) and its parity check matrices ( $V_{i,j}$ )

| H <sub>BG</sub>       |                          | V <sub>i,j</sub>                 |     |     |     |     |     |   |     | H <sub>BG</sub>       |                          | V <sub>i,j</sub>                 |     |     |     |     |     |     |     |
|-----------------------|--------------------------|----------------------------------|-----|-----|-----|-----|-----|---|-----|-----------------------|--------------------------|----------------------------------|-----|-----|-----|-----|-----|-----|-----|
| Row index<br><i>i</i> | Column index<br><i>j</i> | Set index <i>i</i> <sub>LS</sub> |     |     |     |     |     |   |     | Row index<br><i>i</i> | Column index<br><i>j</i> | Set index <i>i</i> <sub>LS</sub> |     |     |     |     |     |     |     |
|                       |                          | 0                                | 1   | 2   | 3   | 4   | 5   | 6 | 7   |                       |                          | 0                                | 1   | 2   | 3   | 4   | 5   | 6   | 7   |
| 0                     | 0                        | 250                              | 307 | 73  | 223 | 211 | 294 | 0 | 135 | 15                    | 1                        | 96                               | 2   | 290 | 120 | 0   | 348 | 6   | 138 |
|                       | 1                        | 69                               | 19  | 15  | 16  | 198 | 118 | 0 | 227 |                       | 10                       | 65                               | 210 | 60  | 131 | 183 | 15  | 81  | 220 |
|                       | 2                        | 226                              | 50  | 103 | 94  | 188 | 167 | 0 | 126 |                       | 13                       | 63                               | 318 | 130 | 209 | 108 | 81  | 182 | 173 |
|                       | 3                        | 159                              | 369 | 49  | 91  | 186 | 330 | 0 | 134 |                       | 18                       | 75                               | 55  | 184 | 209 | 68  | 176 | 53  | 142 |
|                       | 5                        | 100                              | 181 | 240 | 74  | 219 | 207 | 0 | 84  |                       | 25                       | 179                              | 269 | 51  | 81  | 64  | 113 | 46  | 49  |
|                       | 6                        | 10                               | 216 | 39  | 10  | 4   | 165 | 0 | 83  |                       | 37                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                       | 9                        | 59                               | 317 | 15  | 0   | 29  | 243 | 0 | 53  |                       | 1                        | 64                               | 13  | 69  | 154 | 270 | 190 | 88  | 78  |
|                       | 10                       | 229                              | 288 | 162 | 205 | 144 | 250 | 0 | 225 | 3                     | 49                       | 338                              | 140 | 164 | 13  | 293 | 198 | 152 |     |
|                       | 11                       | 110                              | 109 | 215 | 216 | 116 | 1   | 0 | 205 | 11                    | 49                       | 57                               | 45  | 43  | 99  | 332 | 160 | 84  |     |
|                       | 12                       | 191                              | 17  | 164 | 21  | 216 | 339 |   |     |                       |                          |                                  |     |     |     |     |     |     |     |

|    |    |     |     |     |     |     |     |     |     |    |    |     |     |     |     |     |     |     |     |
|----|----|-----|-----|-----|-----|-----|-----|-----|-----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|
|    | 16 | 28  | 241 | 201 | 182 | 254 | 295 | 207 | 210 |    | 10 | 73  | 229 | 23  | 130 | 90  | 16  | 88  | 199 |
|    | 21 | 123 | 51  | 267 | 130 | 79  | 258 | 161 | 180 |    | 13 | 120 | 260 | 105 | 210 | 252 | 95  | 112 | 26  |
|    | 22 | 115 | 157 | 279 | 153 | 144 | 283 | 72  | 180 |    | 24 | 9   | 90  | 135 | 123 | 173 | 212 | 20  | 105 |
|    | 27 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |    | 52 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 6  | 0  | 183 | 278 | 289 | 158 | 80  | 294 | 6   | 199 | 31 | 1  | 95  | 100 | 222 | 175 | 144 | 101 | 4   | 73  |
|    | 6  | 22  | 257 | 21  | 119 | 144 | 73  | 27  | 22  |    | 7  | 177 | 215 | 308 | 49  | 144 | 297 | 49  | 149 |
|    | 10 | 28  | 1   | 293 | 113 | 169 | 330 | 163 | 23  |    | 22 | 172 | 258 | 66  | 177 | 166 | 279 | 125 | 175 |
|    | 11 | 67  | 351 | 13  | 21  | 90  | 99  | 50  | 100 |    | 25 | 61  | 256 | 162 | 128 | 19  | 222 | 194 | 108 |
|    | 13 | 244 | 92  | 232 | 63  | 59  | 172 | 48  | 92  | 32 | 53 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|    | 17 | 11  | 253 | 302 | 51  | 177 | 150 | 24  | 207 |    | 0  | 221 | 102 | 210 | 192 | 0   | 351 | 6   | 103 |
|    | 18 | 157 | 18  | 138 | 136 | 151 | 284 | 38  | 52  |    | 12 | 112 | 201 | 22  | 209 | 211 | 265 | 126 | 110 |
|    | 20 | 211 | 225 | 235 | 116 | 108 | 305 | 91  | 13  |    | 14 | 199 | 175 | 271 | 58  | 36  | 338 | 63  | 151 |
| 7  | 28 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 33 | 24 | 121 | 287 | 217 | 30  | 162 | 83  | 20  | 211 |
|    | 0  | 220 | 9   | 12  | 17  | 169 | 3   | 145 | 77  |    | 54 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|    | 1  | 44  | 62  | 88  | 76  | 189 | 103 | 88  | 146 |    | 1  | 2   | 323 | 170 | 114 | 0   | 56  | 10  | 199 |
|    | 4  | 159 | 316 | 207 | 104 | 154 | 224 | 112 | 209 |    | 2  | 187 | 8   | 20  | 49  | 0   | 304 | 30  | 132 |
|    | 7  | 31  | 333 | 50  | 100 | 184 | 297 | 153 | 32  | 34 | 11 | 41  | 361 | 140 | 161 | 76  | 141 | 6   | 172 |
|    | 8  | 167 | 290 | 25  | 150 | 104 | 215 | 159 | 166 |    | 21 | 211 | 105 | 33  | 137 | 18  | 101 | 92  | 65  |
|    | 14 | 104 | 114 | 76  | 158 | 164 | 39  | 76  | 18  |    | 55 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|    | 29 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |    | 0  | 127 | 230 | 187 | 82  | 197 | 60  | 4   | 161 |
| 8  | 0  | 112 | 307 | 295 | 33  | 54  | 348 | 172 | 181 | 35 | 7  | 167 | 148 | 296 | 186 | 0   | 320 | 153 | 237 |
|    | 1  | 4   | 179 | 133 | 95  | 0   | 75  | 2   | 105 |    | 15 | 164 | 202 | 5   | 68  | 108 | 112 | 197 | 142 |
|    | 3  | 7   | 165 | 130 | 4   | 252 | 22  | 131 | 141 |    | 17 | 159 | 312 | 44  | 150 | 0   | 54  | 155 | 180 |
|    | 12 | 211 | 18  | 231 | 217 | 41  | 312 | 141 | 223 |    | 56 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|    | 16 | 102 | 39  | 296 | 204 | 98  | 224 | 96  | 177 | 36 | 1  | 161 | 320 | 207 | 192 | 199 | 100 | 4   | 231 |
|    | 19 | 164 | 224 | 110 | 39  | 46  | 17  | 99  | 145 |    | 6  | 197 | 335 | 158 | 173 | 278 | 210 | 45  | 174 |
|    | 21 | 109 | 368 | 269 | 58  | 15  | 59  | 101 | 199 |    | 12 | 207 | 2   | 55  | 26  | 0   | 195 | 168 | 145 |
|    | 22 | 241 | 67  | 245 | 44  | 230 | 314 | 35  | 153 |    | 22 | 103 | 266 | 285 | 187 | 205 | 268 | 185 | 100 |
| 9  | 24 | 90  | 170 | 154 | 201 | 54  | 244 | 116 | 38  | 37 | 57 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|    | 30 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |    | 0  | 37  | 210 | 259 | 222 | 216 | 135 | 6   | 11  |
|    | 0  | 103 | 366 | 189 | 9   | 162 | 156 | 6   | 169 |    | 14 | 105 | 313 | 179 | 157 | 16  | 15  | 200 | 207 |
|    | 1  | 182 | 232 | 244 | 37  | 159 | 88  | 10  | 12  |    | 15 | 51  | 297 | 178 | 0   | 0   | 35  | 177 | 42  |
|    | 10 | 109 | 321 | 36  | 213 | 93  | 293 | 145 | 206 | 38 | 18 | 120 | 21  | 160 | 6   | 0   | 188 | 43  | 100 |
|    | 11 | 21  | 133 | 286 | 105 | 134 | 111 | 53  | 221 |    | 58 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|    | 13 | 142 | 57  | 151 | 89  | 45  | 92  | 201 | 17  |    | 1  | 198 | 269 | 298 | 81  | 72  | 319 | 82  | 59  |
|    | 17 | 14  | 303 | 267 | 185 | 132 | 152 | 4   | 212 |    | 13 | 220 | 82  | 15  | 195 | 144 | 236 | 2   | 204 |
| 10 | 18 | 61  | 63  | 135 | 109 | 76  | 23  | 164 | 92  | 39 | 23 | 122 | 115 | 115 | 138 | 0   | 85  | 135 | 161 |
|    | 20 | 216 | 82  | 209 | 218 | 209 | 337 | 173 | 205 |    | 59 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|    | 31 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |    | 0  | 167 | 185 | 151 | 123 | 190 | 164 | 91  | 121 |
|    | 1  | 98  | 101 | 14  | 82  | 178 | 175 | 126 | 116 |    | 9  | 151 | 177 | 179 | 90  | 0   | 196 | 64  | 90  |
|    | 2  | 149 | 339 | 80  | 165 | 1   | 253 | 77  | 151 | 40 | 10 | 157 | 289 | 64  | 73  | 0   | 209 | 198 | 26  |
|    | 4  | 167 | 274 | 211 | 174 | 28  | 27  | 156 | 70  |    | 12 | 163 | 214 | 181 | 10  | 0   | 246 | 100 | 140 |
|    | 7  | 160 | 111 | 75  | 19  | 267 | 231 | 16  | 230 |    | 60 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|    | 8  | 49  | 383 | 161 | 194 | 234 | 49  | 12  | 115 |    | 1  | 173 | 258 | 102 | 12  | 153 | 236 | 4   | 115 |
| 11 | 14 | 58  | 354 | 311 | 103 | 201 | 267 | 70  | 84  | 41 | 3  | 139 | 93  | 77  | 77  | 0   | 264 | 28  | 188 |
|    | 32 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |    | 7  | 149 | 346 | 192 | 49  | 165 | 37  | 109 | 168 |
|    | 0  | 77  | 48  | 16  | 52  | 55  | 25  | 184 | 45  |    | 19 | 0   | 297 | 208 | 114 | 117 | 272 | 188 | 52  |
|    | 1  | 41  | 102 | 147 | 11  | 23  | 322 | 194 | 115 |    | 61 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|    | 12 | 83  | 8   | 290 | 2   | 274 | 200 | 123 | 134 | 42 | 0  | 157 | 175 | 32  | 67  | 216 | 304 | 10  | 4   |
|    | 16 | 182 | 47  | 289 | 35  | 181 | 351 | 16  | 1   |    | 8  | 137 | 37  | 80  | 45  | 144 | 237 | 84  | 103 |
|    | 21 | 78  | 188 | 177 | 32  | 273 | 166 | 104 | 152 |    | 17 | 149 | 312 | 197 | 96  | 2   | 135 | 12  | 30  |
|    | 22 | 252 | 334 | 43  | 84  | 39  | 338 | 109 | 165 |    | 62 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 12 | 23 | 22  | 115 | 280 | 201 | 26  | 192 | 124 | 107 | 43 | 1  | 167 | 52  | 154 | 23  | 0   | 123 | 2   | 53  |
|    | 33 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |    | 3  | 173 | 314 | 47  | 215 | 0   | 77  | 75  | 189 |
|    | 0  | 160 | 77  | 229 | 142 | 225 | 123 | 6   | 186 |    | 9  | 139 | 139 | 124 | 60  | 0   | 25  | 142 | 215 |
|    | 1  | 42  | 186 | 235 | 175 | 162 | 217 | 20  | 215 |    | 18 | 151 | 288 | 207 | 167 | 183 | 272 | 128 | 24  |
|    | 10 | 21  | 174 | 169 | 136 | 244 | 142 | 203 | 124 | 44 | 63 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|    | 11 | 32  | 232 | 48  | 3   | 151 | 110 | 153 | 180 |    | 0  | 149 | 113 | 226 | 114 | 27  | 288 | 163 | 222 |
|    | 13 | 234 | 50  | 105 | 28  | 238 | 176 | 104 | 98  |    | 4  | 157 | 14  | 65  | 91  | 0   | 83  | 10  | 170 |
|    | 18 | 7   | 74  | 52  | 182 | 243 | 76  | 207 | 80  |    | 24 | 137 | 218 | 126 | 78  | 35  | 17  | 162 | 71  |
| 13 | 34 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 45 | 64 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|    | 0  | 177 | 313 | 39  | 81  | 231 | 311 | 52  | 220 |    | 1  | 151 | 113 | 228 | 206 | 52  | 210 | 1   | 22  |
|    | 3  | 248 | 177 | 302 | 56  | 0   | 251 | 147 | 185 |    | 16 | 163 | 132 | 69  | 22  | 243 | 3   | 163 | 127 |
|    | 7  | 151 | 266 | 303 | 72  | 216 | 265 | 1   | 154 |    | 18 | 173 | 114 | 176 | 134 | 0   | 53  | 99  | 49  |
|    | 20 | 185 | 115 | 160 | 217 | 47  | 94  | 16  | 178 | 46 | 25 | 139 | 168 | 102 | 161 | 270 | 167 | 98  | 125 |
|    | 23 | 62  | 370 | 37  | 78  | 36  | 81  | 46  | 150 |    | 65 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|    | 35 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |    | 0  | 139 | 80  | 234 | 84  | 18  | 79  | 4   | 191 |
|    | 0  | 206 | 142 | 78  | 14  | 0   | 22  | 1   | 124 |    | 7  | 157 | 78  | 227 | 4   | 0   | 244 | 6   | 211 |
| 14 | 12 | 55  | 248 | 299 | 175 | 186 | 322 | 202 | 144 | 47 | 9  | 163 | 163 | 259 | 9   | 0   | 293 | 142 | 187 |
|    | 15 | 206 | 137 | 54  | 211 | 253 | 277 | 118 | 182 |    | 22 | 173 | 274 | 260 | 12  | 57  | 272 | 3   | 148 |
|    | 16 | 127 | 89  | 61  | 191 | 16  | 156 | 130 | 95  |    | 66 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|    | 17 | 16  | 347 | 179 | 51  | 0   | 66  | 1   | 72  |    | 1  | 149 | 135 | 101 | 184 | 168 | 82  | 181 | 177 |
|    | 21 | 229 | 12  | 258 | 43  | 79  | 78  | 2   | 76  | 48 | 6  | 151 | 149 | 228 | 121 | 0   | 67  | 45  | 114 |
|    | 36 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |    | 10 | 167 | 15  | 126 | 29  | 144 | 235 | 153 | 93  |
|    | 0  | 40  | 241 | 229 | 90  | 170 | 176 | 173 | 39  |    | 67 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|    | 15 | 0   | 40  | 241 | 229 | 90  | 170 | 176 | 173 |    | 67 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |



Table 5.3.2-3: LDPC base graph 2 ( $H_{BG}$ ) and its parity check matrices ( $V_{i,j}$ )

| H <sub>BG</sub>       |                          | V <sub>i,j</sub>                 |     |     |     |     |     |     |     | H <sub>BG</sub>       |                          | V <sub>i,j</sub>                 |     |     |     |     |     |     |     |
|-----------------------|--------------------------|----------------------------------|-----|-----|-----|-----|-----|-----|-----|-----------------------|--------------------------|----------------------------------|-----|-----|-----|-----|-----|-----|-----|
| Row index<br><i>i</i> | Column index<br><i>j</i> | Set index <i>i</i> <sub>LS</sub> |     |     |     |     |     |     |     | Row index<br><i>i</i> | Column index<br><i>j</i> | Set index <i>i</i> <sub>LS</sub> |     |     |     |     |     |     |     |
|                       |                          | 0                                | 1   | 2   | 3   | 4   | 5   | 6   | 7   |                       |                          | 0                                | 1   | 2   | 3   | 4   | 5   | 6   | 7   |
| 0                     | 0                        | 9                                | 174 | 0   | 72  | 3   | 156 | 143 | 145 | 16                    | 26                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   |     |
|                       | 1                        | 117                              | 97  | 0   | 110 | 26  | 143 | 19  | 131 | 17                    | 1                        | 254                              | 158 | 0   | 48  | 120 | 134 | 57  | 196 |
|                       | 2                        | 204                              | 166 | 0   | 23  | 53  | 14  | 176 | 71  |                       | 5                        | 124                              | 23  | 24  | 132 | 43  | 23  | 201 | 173 |
|                       | 3                        | 26                               | 66  | 0   | 181 | 35  | 3   | 165 | 21  |                       | 11                       | 114                              | 9   | 109 | 206 | 65  | 62  | 142 | 195 |
|                       | 6                        | 189                              | 71  | 0   | 95  | 115 | 40  | 196 | 23  |                       | 12                       | 64                               | 6   | 18  | 2   | 42  | 163 | 35  | 218 |
|                       | 9                        | 205                              | 172 | 0   | 8   | 127 | 123 | 13  | 112 |                       | 27                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                       | 10                       | 0                                | 0   | 0   | 1   | 0   | 0   | 0   | 1   | 0                     | 220                      | 186                              | 0   | 68  | 17  | 173 | 129 | 128 |     |
| 11                    | 0                        | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 6                     | 194                      | 6                                | 18  | 16  | 106 | 31  | 203 | 211 |     |
| 1                     | 0                        | 167                              | 27  | 137 | 53  | 19  | 17  | 18  | 142 | 18                    | 7                        | 50                               | 46  | 86  | 156 | 142 | 22  | 140 | 210 |
|                       | 3                        | 166                              | 36  | 124 | 156 | 94  | 65  | 27  | 174 |                       | 28                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                       | 4                        | 253                              | 48  | 0   | 115 | 104 | 63  | 3   | 183 |                       | 0                        | 87                               | 58  | 0   | 35  | 79  | 13  | 110 | 39  |
|                       | 5                        | 125                              | 92  | 0   | 156 | 66  | 1   | 102 | 27  | 19                    | 1                        | 20                               | 42  | 158 | 138 | 28  | 135 | 124 | 84  |
|                       | 6                        | 226                              | 31  | 88  | 115 | 84  | 55  | 185 | 96  |                       | 10                       | 185                              | 156 | 154 | 86  | 41  | 145 | 52  | 88  |
|                       | 7                        | 156                              | 187 | 0   | 200 | 98  | 37  | 17  | 23  |                       | 29                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                       | 8                        | 224                              | 185 | 0   | 29  | 69  | 171 | 14  | 9   |                       | 1                        | 26                               | 76  | 0   | 6   | 2   | 128 | 196 | 117 |
|                       | 9                        | 252                              | 3   | 55  | 31  | 50  | 133 | 180 | 167 |                       | 4                        | 105                              | 61  | 148 | 20  | 103 | 52  | 35  | 227 |
|                       | 11                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 20                    | 11                       | 29                               | 153 | 104 | 141 | 78  | 173 | 114 | 6   |
|                       | 12                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |                       | 30                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                       | 0                        | 81                               | 25  | 20  | 152 | 95  | 98  | 126 | 74  |                       | 0                        | 76                               | 157 | 0   | 80  | 91  | 156 | 10  | 238 |
| 1                     | 114                      | 114                              | 94  | 131 | 106 | 168 | 163 | 31  | 8   |                       | 42                       | 175                              | 17  | 43  | 75  | 166 | 122 | 13  |     |
| 3                     | 44                       | 117                              | 99  | 46  | 92  | 107 | 47  | 3   | 13  |                       | 210                      | 67                               | 33  | 81  | 81  | 40  | 23  | 11  |     |
| 2                     | 4                        | 52                               | 110 | 9   | 191 | 110 | 82  | 183 | 53  | 21                    | 31                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                       | 8                        | 240                              | 114 | 108 | 91  | 111 | 142 | 132 | 155 |                       | 1                        | 222                              | 20  | 0   | 49  | 54  | 18  | 202 | 195 |
|                       | 10                       | 1                                | 1   | 1   | 0   | 1   | 1   | 1   | 0   |                       | 2                        | 63                               | 52  | 4   | 1   | 132 | 163 | 126 | 44  |
|                       | 12                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 22                    | 32                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                       | 13                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |                       | 0                        | 23                               | 106 | 0   | 156 | 68  | 110 | 52  | 5   |
|                       | 1                        | 8                                | 136 | 38  | 185 | 120 | 53  | 36  | 239 |                       | 3                        | 235                              | 86  | 75  | 54  | 115 | 132 | 170 | 94  |
|                       | 2                        | 58                               | 175 | 15  | 6   | 121 | 174 | 48  | 171 | 5                     | 238                      | 95                               | 158 | 134 | 56  | 150 | 13  | 111 |     |
| 3                     | 4                        | 158                              | 113 | 102 | 36  | 22  | 174 | 18  | 95  | 23                    | 33                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                       | 5                        | 104                              | 72  | 146 | 124 | 4   | 127 | 111 | 110 |                       | 1                        | 46                               | 182 | 0   | 153 | 30  | 113 | 113 | 81  |
|                       | 6                        | 209                              | 123 | 12  | 124 | 73  | 17  | 203 | 159 |                       | 2                        | 139                              | 153 | 69  | 88  | 42  | 108 | 161 | 19  |
|                       | 7                        | 54                               | 118 | 57  | 110 | 49  | 89  | 3   | 199 |                       | 9                        | 8                                | 64  | 87  | 63  | 101 | 61  | 88  | 130 |
|                       | 8                        | 18                               | 28  | 53  | 156 | 128 | 17  | 191 | 43  |                       | 34                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                       | 9                        | 128                              | 186 | 46  | 133 | 79  | 105 | 160 | 75  | 0                     | 228                      | 45                               | 0   | 211 | 128 | 72  | 197 | 66  |     |
|                       | 10                       | 0                                | 0   | 0   | 1   | 0   | 0   | 0   | 1   | 5                     | 156                      | 21                               | 65  | 94  | 63  | 136 | 194 | 95  |     |
|                       | 13                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 35                    | 0                        | 0                                | 0   | 0   | 0   | 0   | 0   | 0   |     |
|                       | 0                        | 179                              | 72  | 0   | 200 | 42  | 86  | 43  | 29  | 2                     | 29                       | 67                               | 0   | 90  | 142 | 36  | 164 | 146 |     |
|                       | 1                        | 214                              | 74  | 136 | 16  | 24  | 67  | 27  | 140 | 7                     | 143                      | 137                              | 100 | 6   | 28  | 38  | 172 | 66  |     |
|                       | 4                        | 11                               | 71  | 29  | 157 | 101 | 51  | 83  | 117 | 180                   | 26                       | 12                               | 160 | 55  | 13  | 221 | 100 | 53  | 49  |
| 14                    |                          | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 13                    |                          | 122                              | 85  | 7   | 6   | 133 | 145 | 161 | 86  |
| 0                     |                          | 231                              | 10  | 0   | 185 | 40  | 79  | 136 | 121 | 36                    |                          | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 1                     |                          | 41                               | 44  | 131 | 138 | 140 | 84  | 49  | 41  | 0                     |                          | 8                                | 103 | 0   | 27  | 13  | 42  | 168 | 64  |
| 5                     |                          | 194                              | 121 | 142 | 170 | 84  | 35  | 36  | 169 | 6                     |                          | 151                              | 50  | 32  | 118 | 10  | 104 | 193 | 181 |
| 7                     |                          | 159                              | 80  | 141 | 219 | 137 | 103 | 132 | 88  | 37                    | 0                        | 0                                | 0   | 0   | 0   | 0   | 0   | 0   |     |
| 11                    |                          | 103                              | 48  | 64  | 193 | 71  | 60  | 62  | 207 | 27                    | 0                        | 8                                | 103 | 0   | 27  | 13  | 42  | 168 | 64  |
| 15                    | 0                        | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 6   |                       | 151                      | 50                               | 32  | 118 | 10  | 104 | 193 | 181 |     |
| 0                     | 155                      | 129                              | 0   | 123 | 109 | 47  | 7   | 137 | 37  |                       | 0                        | 0                                | 0   | 0   | 0   | 0   | 0   | 0   |     |
| 5                     | 228                      | 92                               | 124 | 55  | 87  | 154 | 34  | 72  | 1   |                       | 98                       | 70                               | 0   | 216 | 106 | 64  | 14  | 7   |     |
| 7                     | 45                       | 100                              | 99  | 31  | 107 | 10  | 198 | 172 | 2   |                       | 101                      | 111                              | 126 | 212 | 77  | 24  | 186 | 144 |     |
| 6                     | 9                        | 28                               | 49  | 45  | 222 | 133 | 155 | 168 | 124 | 28                    | 5                        | 135                              | 168 | 110 | 193 | 43  | 149 | 46  | 16  |
|                       | 11                       | 158                              | 184 | 148 | 209 | 139 | 29  | 12  | 56  |                       | 38                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                       | 16                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |                       | 0                        | 18                               | 110 | 0   | 108 | 133 | 139 | 50  | 25  |
|                       | 0                        | 129                              | 80  | 0   | 103 | 97  | 48  | 163 | 86  |                       | 4                        | 28                               | 17  | 154 | 61  | 25  | 161 | 27  | 57  |
|                       | 5                        | 147                              | 186 | 45  | 13  | 135 | 125 | 78  | 186 |                       | 39                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                       | 7                        | 140                              | 16  | 148 | 105 | 35  | 24  | 143 | 87  | 2                     | 71                       | 120                              | 0   | 106 | 87  | 84  | 70  | 37  |     |
|                       | 11                       | 3                                | 102 | 96  | 150 | 108 | 47  | 107 | 172 | 5                     | 240                      | 154                              | 35  | 44  | 56  | 173 | 17  | 139 |     |
| 7                     | 13                       | 116                              | 143 | 78  | 181 | 65  | 55  | 58  | 154 | 30                    | 7                        | 9                                | 52  | 51  | 185 | 104 | 93  | 50  | 221 |
|                       | 17                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |                       | 9                        | 84                               | 56  | 134 | 176 | 70  | 29  | 6   | 17  |
|                       | 0                        | 142                              | 118 | 0   | 147 | 70  | 53  | 101 | 176 |                       | 40                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                       | 1                        | 129                              | 80  | 0   | 103 | 97  | 48  | 163 | 86  |                       | 1                        | 106                              | 3   | 0   | 147 | 80  | 117 | 115 | 201 |
|                       | 5                        | 147                              | 186 | 45  | 13  | 135 | 125 | 78  | 186 |                       | 13                       | 1                                | 170 | 20  | 182 | 139 | 148 | 189 | 46  |
|                       | 7                        | 140                              | 16  | 148 | 105 | 35  | 24  | 143 | 87  | 41                    | 0                        | 0                                | 0   | 0   | 0   | 0   | 0   | 0   |     |
|                       | 11                       | 3                                | 102 | 96  | 150 | 108 | 47  | 107 | 172 | 31                    | 0                        | 147                              | 173 | 0   | 29  | 37  | 11  | 197 | 184 |
| 0                     | 142                      | 118                              | 0   | 147 | 70  | 53  | 101 | 176 | 12  |                       | 85                       | 177                              | 19  | 201 | 25  | 41  | 191 | 135 |     |
| 1                     | 94                       | 70                               | 65  | 43  | 69  | 31  | 177 | 169 | 13  |                       | 36                       | 12                               | 78  | 69  | 114 | 162 | 193 | 141 |     |
| 12                    | 230                      | 152                              | 87  | 152 | 88  | 161 | 22  | 225 | 44  |                       | 0                        | 0                                | 0   | 0   | 0   | 0   | 0   | 0   |     |
| 18                    | 0                        | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |                       | 0                        | 0                                | 0   | 0   | 0   | 0   | 0   | 0   |     |
| 8                     | 1                        | 203                              | 28  | 0   | 2   | 97  | 104 | 186 | 167 | 32                    | 0                        | 242                              | 84  | 0   | 108 | 32  | 116 | 110 | 179 |
|                       | 8                        | 205                              | 132 | 97  | 30  | 40  | 142 | 27  | 238 |                       | 5                        | 44                               | 8   | 20  | 21  | 89  | 73  | 0   | 14  |
|                       | 10                       | 61                               | 185 | 51  | 184 | 24  | 99  | 205 | 48  |                       | 12                       | 166                              | 17  | 122 | 110 | 71  | 142 | 163 | 116 |
|                       | 11                       | 247                              | 178 | 85  | 83  | 49  | 64  | 81  | 68  |                       | 42                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                       | 19                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |                       | 2                        | 132                              | 165 | 0   | 71  | 135 | 105 | 163 | 46  |
|                       | 0                        | 11                               | 59  | 0   | 174 | 46  | 111 | 125 | 38  | 7                     | 164                      | 179                              | 88  | 12  | 6   | 137 | 173 | 2   |     |
|                       | 1                        | 185                              | 104 | 17  | 150 | 41  | 25  | 60  | 217 | 33                    | 10                       | 235                              | 124 | 13  | 109 | 2   | 29  | 179 | 106 |
| 6                     | 0                        | 22                               | 156 | 8   | 101 | 174 | 177 | 208 | 43  |                       | 0                        | 0                                | 0   | 0   | 0   | 0   | 0   | 0   |     |
| 7                     | 117                      | 52                               | 20  | 56  | 96  | 23  | 51  | 232 | 0   |                       | 147                      | 173                              | 0   | 29  | 37  | 11  | 197 | 184 |     |
| 20                    | 0                        | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 1   |                       | 57                       | 77                               | 0   | 91  | 60  | 126 | 157 | 85  |     |
| 0                     | 11                       | 32                               | 0   | 99  | 28  | 91  | 39  | 178 | 5   |                       | 40                       | 184                              | 157 | 165 | 137 | 152 | 167 | 225 |     |
| 9                     | 7                        | 236                              | 92  | 7   | 138 | 30  | 175 | 29  | 214 | 34                    | 11                       | 63                               | 18  | 6   | 55  | 93  | 172 | 181 | 175 |
|                       | 9                        | 210                              | 174 | 4   | 110 | 116 | 24  | 35  | 168 |                       | 45                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|                       | 13                       | 56                               | 154 | 2   | 99  | 64  | 141 | 8   | 51  |                       | 0                        | 140                              | 25  | 0   | 1   | 121 | 73  | 197 | 178 |
|                       | 21                       | 0                                | 0   | 0   | 0   | 0   | 0   | 0   | 0   |                       | 2                        | 38                               | 151 | 63  | 175 | 129 | 154 | 167 | 112 |
|                       | 1                        | 63                               | 39  | 0   | 46  | 33  | 122 | 18  | 124 |                       | 7                        | 154                              | 170 | 82  | 83  | 26  | 129 | 179 | 106 |
|                       | 3                        | 111                              | 93  | 113 | 217 | 122 | 11  | 155 | 122 | 46                    | 0                        | 0                                | 0   | 0   | 0   | 0   | 0   | 0   |     |
|                       | 11                       | 14                               | 11  | 48  | 109 | 131 | 4   | 49  | 72  | 1                     |                          |                                  |     |     |     |     |     |     |     |

|    |    |     |     |     |     |     |     |     |     |    |    |     |     |     |     |     |     |     |     |
|----|----|-----|-----|-----|-----|-----|-----|-----|-----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|
| 14 | 8  | 38  | 35  | 102 | 143 | 62  | 27  | 95  | 167 | 39 | 5  | 66  | 151 | 93  | 97  | 70  | 7   | 173 | 41  |
|    | 13 | 222 | 166 | 26  | 140 | 47  | 127 | 186 | 219 |    | 11 | 38  | 190 | 19  | 46  | 1   | 19  | 191 | 105 |
|    | 23 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |    | 48 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|    | 1  | 115 | 19  | 0   | 36  | 143 | 11  | 91  | 82  |    | 0  | 239 | 93  | 0   | 106 | 119 | 109 | 181 | 167 |
|    | 6  | 145 | 118 | 138 | 95  | 51  | 145 | 20  | 232 |    | 7  | 172 | 132 | 24  | 181 | 32  | 6   | 157 | 45  |
|    | 11 | 3   | 21  | 57  | 40  | 130 | 8   | 52  | 204 |    | 12 | 34  | 57  | 138 | 154 | 142 | 105 | 173 | 189 |
|    | 13 | 232 | 163 | 27  | 116 | 97  | 166 | 109 | 162 |    | 49 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|    | 24 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |    | 2  | 0   | 103 | 0   | 98  | 6   | 160 | 193 | 78  |
| 15 | 0  | 51  | 68  | 0   | 116 | 139 | 137 | 174 | 38  | 40 | 10 | 75  | 107 | 36  | 35  | 73  | 156 | 163 | 67  |
|    | 10 | 175 | 63  | 73  | 200 | 96  | 103 | 108 | 217 |    | 13 | 120 | 163 | 143 | 36  | 102 | 82  | 179 | 180 |
|    | 11 | 213 | 81  | 99  | 110 | 128 | 40  | 102 | 157 |    | 50 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|    | 25 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |    | 1  | 129 | 147 | 0   | 120 | 48  | 132 | 191 | 53  |
| 16 | 1  | 203 | 87  | 0   | 75  | 48  | 78  | 125 | 170 | 41 | 5  | 229 | 7   | 2   | 101 | 47  | 6   | 197 | 215 |
|    | 9  | 142 | 177 | 79  | 158 | 9   | 158 | 31  | 23  |    | 11 | 118 | 60  | 55  | 81  | 19  | 8   | 167 | 230 |
|    | 11 | 8   | 135 | 111 | 134 | 28  | 17  | 54  | 175 |    | 51 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|    | 12 | 242 | 64  | 143 | 97  | 8   | 165 | 176 | 202 |    |    |     |     |     |     |     |     |     |     |

### 5.3.3 Channel coding of small block lengths

The bit sequence input for a given code block to channel coding is denoted by  $c_0, c_1, c_2, c_3, \dots, c_{K-1}$ , where  $K$  is the number of bits to encode. After encoding the bits are denoted by  $d_0, d_1, d_2, \dots, d_{N-1}$ .

#### 5.3.3.1 Encoding of 1-bit information

For  $K = 1$ , the code block is encoded according to Table 5.3.3.1-1, where  $N = Q_m$  and  $Q_m$  is the modulation order for the code block.

**Table 5.3.3.1-1: Encoding of 1-bit information**

| $Q_m$ | Encoded bits $d_0, d_1, d_2, \dots, d_{N-1}$ |
|-------|----------------------------------------------|
| 1     | $[c_0]$                                      |
| 2     | $[c_0 \ y]$                                  |
| 4     | $[c_0 \ y \ x \ x]$                          |
| 6     | $[c_0 \ y \ x \ x \ x \ x]$                  |
| 8     | $[c_0 \ y \ x \ x \ x \ x \ x \ x]$          |

The "x" and "y" in Table 5.3.3.1-1 are placeholders for Clauses 6.3.1.1, 6.3.2.5.1, 6.3.2.6.1 of [4, TS 38.211] to scramble the information bits in a way that maximizes the Euclidean distance of the modulation symbols carrying the information bits.

#### 5.3.3.2 Encoding of 2-bit information

For  $K = 2$ , the code block is encoded according to Table 5.3.3.2-1, where  $c_2 = (c_0 + c_1) \bmod 2$ ,  $N = 3Q_m$ , and  $Q_m$  is the modulation order for the code block.

**Table 5.3.3.2-1: Encoding of 2-bit information**

| $Q_m$ | Encoded bits $d_0, d_1, d_2, \dots, d_{N-1}$                                                                  |
|-------|---------------------------------------------------------------------------------------------------------------|
| 1     | $[c_0 \ c_1 \ c_2]$                                                                                           |
| 2     | $[c_0 \ c_1 \ c_2 \ c_0 \ c_1 \ c_2]$                                                                         |
| 4     | $[c_0 \ c_1 \ x \ x \ c_2 \ c_0 \ x \ x \ c_1 \ c_2 \ x \ x]$                                                 |
| 6     | $[c_0 \ c_1 \ x \ x \ x \ x \ c_2 \ c_0 \ x \ x \ x \ x \ c_1 \ c_2 \ x \ x \ x \ x]$                         |
| 8     | $[c_0 \ c_1 \ x \ x \ x \ x \ x \ x \ c_2 \ c_0 \ x \ x \ x \ x \ x \ x \ c_1 \ c_2 \ x \ x \ x \ x \ x \ x]$ |

The "x" in Table 5.3.3.2-1 are placeholders for Clause 6.3.1.1 of [4, TS 38.211] to scramble the information bits in a way that maximizes the Euclidean distance of the modulation symbols carrying the information bits.

### 5.3.3.3 Encoding of other small block lengths

For  $3 \leq K \leq 11$ , the code block is encoded by  $d_i = \left( \sum_{k=0}^{K-1} c_k \cdot M_{i,k} \right) \bmod 2$ , where  $i = 0, 1, \dots, N-1$ ,  $N = 32$ , and  $M_{i,k}$  represents the basis sequences as defined in Table 5.3.3.3-1.

**Table 5.3.3.3-1: Basis sequences for (32,  $K$ ) code**

| i  | M <sub>i,0</sub> | M <sub>i,1</sub> | M <sub>i,2</sub> | M <sub>i,3</sub> | M <sub>i,4</sub> | M <sub>i,5</sub> | M <sub>i,6</sub> | M <sub>i,7</sub> | M <sub>i,8</sub> | M <sub>i,9</sub> | M <sub>i,10</sub> |
|----|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|-------------------|
| 0  | 1                | 1                | 0                | 0                | 0                | 0                | 0                | 0                | 0                | 0                | 1                 |
| 1  | 1                | 1                | 1                | 0                | 0                | 0                | 0                | 0                | 0                | 1                | 1                 |
| 2  | 1                | 0                | 0                | 1                | 0                | 0                | 1                | 0                | 1                | 1                | 1                 |
| 3  | 1                | 0                | 1                | 1                | 0                | 0                | 0                | 0                | 1                | 0                | 1                 |
| 4  | 1                | 1                | 1                | 1                | 0                | 0                | 0                | 1                | 0                | 0                | 1                 |
| 5  | 1                | 1                | 0                | 0                | 1                | 0                | 1                | 1                | 1                | 0                | 1                 |
| 6  | 1                | 0                | 1                | 0                | 1                | 0                | 1                | 0                | 1                | 1                | 1                 |
| 7  | 1                | 0                | 0                | 1                | 1                | 0                | 0                | 1                | 1                | 0                | 1                 |
| 8  | 1                | 1                | 0                | 1                | 1                | 0                | 0                | 1                | 0                | 1                | 1                 |
| 9  | 1                | 0                | 1                | 1                | 1                | 0                | 1                | 0                | 0                | 1                | 1                 |
| 10 | 1                | 0                | 1                | 0                | 0                | 1                | 1                | 1                | 0                | 1                | 1                 |
| 11 | 1                | 1                | 1                | 0                | 0                | 1                | 1                | 0                | 1                | 0                | 1                 |
| 12 | 1                | 0                | 0                | 1                | 0                | 1                | 0                | 1                | 1                | 1                | 1                 |
| 13 | 1                | 1                | 0                | 1                | 0                | 1                | 0                | 1                | 0                | 1                | 1                 |
| 14 | 1                | 0                | 0                | 0                | 1                | 1                | 0                | 1                | 0                | 0                | 1                 |
| 15 | 1                | 1                | 0                | 0                | 1                | 1                | 1                | 1                | 0                | 1                | 1                 |
| 16 | 1                | 1                | 1                | 0                | 1                | 1                | 1                | 0                | 0                | 1                | 0                 |
| 17 | 1                | 0                | 0                | 1                | 1                | 1                | 0                | 0                | 1                | 0                | 0                 |
| 18 | 1                | 1                | 0                | 1                | 1                | 1                | 1                | 1                | 0                | 0                | 0                 |
| 19 | 1                | 0                | 0                | 0                | 0                | 1                | 1                | 0                | 0                | 0                | 0                 |
| 20 | 1                | 0                | 1                | 0                | 0                | 0                | 1                | 0                | 0                | 0                | 1                 |
| 21 | 1                | 1                | 0                | 1                | 0                | 0                | 0                | 0                | 0                | 1                | 1                 |
| 22 | 1                | 0                | 0                | 0                | 1                | 0                | 0                | 1                | 1                | 0                | 1                 |
| 23 | 1                | 1                | 1                | 0                | 1                | 0                | 0                | 0                | 1                | 1                | 1                 |
| 24 | 1                | 1                | 1                | 1                | 1                | 0                | 1                | 1                | 1                | 1                | 0                 |
| 25 | 1                | 1                | 0                | 0                | 0                | 1                | 1                | 1                | 0                | 0                | 1                 |
| 26 | 1                | 0                | 1                | 1                | 0                | 1                | 0                | 0                | 1                | 1                | 0                 |
| 27 | 1                | 1                | 1                | 1                | 0                | 1                | 0                | 1                | 1                | 1                | 0                 |
| 28 | 1                | 0                | 1                | 0                | 1                | 1                | 1                | 0                | 1                | 0                | 0                 |
| 29 | 1                | 0                | 1                | 1                | 1                | 1                | 1                | 1                | 1                | 0                | 0                 |
| 30 | 1                | 1                | 1                | 1                | 1                | 1                | 1                | 1                | 1                | 1                | 1                 |
| 31 | 1                | 0                | 0                | 0                | 0                | 0                | 0                | 0                | 0                | 0                | 0                 |

## 5.4 Rate matching

### 5.4.1 Rate matching for Polar code

The rate matching for Polar code is defined per coded block and consists of sub-block interleaving, bit collection, and bit interleaving. The input bit sequence to rate matching is  $d_0, d_1, d_2, \dots, d_{N-1}$ . The output bit sequence after rate matching is denoted as  $f_0, f_1, f_2, \dots, f_{E-1}$ .

#### 5.4.1.1 Sub-block interleaving

The bits input to the sub-block interleaver are the coded bits  $d_0, d_1, d_2, \dots, d_{N-1}$ . The coded bits  $d_0, d_1, d_2, \dots, d_{N-1}$  are divided into 32 sub-blocks. The bits output from the sub-block interleaver are denoted as  $y_0, y_1, y_2, \dots, y_{N-1}$ , generated as follows:

for  $n=0$  to  $N-1$

$$i = \lfloor 32n / N \rfloor;$$

$$J(n) = P(i) \times (N/32) + \text{mod}(n, N/32);$$

$$y_n = d_{J(n)};$$

end for

where the sub-block interleaver pattern  $P(i)$  is given by Table 5.4.1.1-1.

**Table 5.4.1.1-1: Sub-block interleaver pattern  $P(i)$**

| $i$ | $P(i)$ | $i$ | $P(i)$ | $i$ | $P(i)$ | $i$ | $P(i)$ | $i$ | $P(i)$ | $i$ | $P(i)$ | $i$ | $P(i)$ | $i$ | $P(i)$ |
|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|
| 0   | 0      | 4   | 3      | 8   | 8      | 12  | 10     | 16  | 12     | 20  | 14     | 24  | 24     | 28  | 27     |
| 1   | 1      | 5   | 5      | 9   | 16     | 13  | 18     | 17  | 20     | 21  | 22     | 25  | 25     | 29  | 29     |
| 2   | 2      | 6   | 6      | 10  | 9      | 14  | 11     | 18  | 13     | 22  | 15     | 26  | 26     | 30  | 30     |
| 3   | 4      | 7   | 7      | 11  | 17     | 15  | 19     | 19  | 21     | 23  | 23     | 27  | 28     | 31  | 31     |

The sets of bit indices  $\overline{\mathbf{Q}}_I^N$  and  $\overline{\mathbf{Q}}_F^N$  are determined as follows, where  $K$ ,  $n_{PC}$ , and  $\mathbf{Q}_0^{N-1}$  are defined in Clause 5.3.1

$$\overline{\mathbf{Q}}_{F,tmp}^N = \emptyset$$

if  $E < N$

if  $K/E \leq 7/16$  -- puncturing

for  $n=0$  to  $N-E-1$

$$\overline{\mathbf{Q}}_{F,tmp}^N = \overline{\mathbf{Q}}_{F,tmp}^N \cup \{J(n)\};$$

end for

if  $E \geq 3N/4$

$$\overline{\mathbf{Q}}_{F,tmp}^N = \overline{\mathbf{Q}}_{F,tmp}^N \cup \{0, 1, \dots, \lceil 3N/4 - E/2 \rceil - 1\};$$

else

$$\overline{\mathbf{Q}}_{F,tmp}^N = \overline{\mathbf{Q}}_{F,tmp}^N \cup \{0, 1, \dots, \lceil 9N/16 - E/4 \rceil - 1\};$$

end if

else -- shortening

for  $n=E$  to  $N-1$

$$\overline{\mathbf{Q}}_{F,tmp}^N = \overline{\mathbf{Q}}_{F,tmp}^N \cup \{J(n)\};$$

end for

end if

end if

$$\overline{\mathbf{Q}}_{I,tmp}^N = \mathbf{Q}_0^{N-1} \setminus \overline{\mathbf{Q}}_{F,tmp}^N;$$

$\overline{\mathbf{Q}}_I^N$  comprises  $(K + n_{PC})$  most reliable bit indices in  $\overline{\mathbf{Q}}_{I,tmp}^N$ ;

$$\overline{\mathbf{Q}}_F^N = \mathbf{Q}_0^{N-1} \setminus \overline{\mathbf{Q}}_I^N;$$

### 5.4.1.2 Bit selection

The bit sequence after the sub-block interleaver  $y_0, y_1, y_2, \dots, y_{N-1}$  from Clause 5.4.1.1 is written into a circular buffer of length  $N$ .

Denoting by  $E$  the rate matching output sequence length, the bit selection output bit sequence  $e_k$ ,  $k=0,1,2,\dots,E-1$ , is generated as follows:

```

if  $E \geq N$  -- repetition
  for  $k=0$  to  $E-1$ 
     $e_k = y_{\text{mod}(k,N)}$ ;
  end for
else
  if  $K/E \leq 7/16$  -- puncturing
    for  $k=0$  to  $E-1$ 
       $e_k = y_{k+N-E}$ ;
    end for
  else -- shortening
    for  $k=0$  to  $E-1$ 
       $e_k = y_k$ ;
    end for
  end if
end if

```

### 5.4.1.3 Interleaving of coded bits

The bit sequence  $e_0, e_1, e_2, \dots, e_{E-1}$  is interleaved into bit sequence  $f_0, f_1, f_2, \dots, f_{E-1}$ , as follows:

If  $I_{BIL}=1$

Denote  $T$  as the smallest integer such that  $T(T+1)/2 \geq E$ ;

$k=0$ ;

for  $i=0$  to  $T-1$

for  $j=0$  to  $T-1-i$

if  $k < E$

$v_{i,j} = e_k$ ;

else

$v_{i,j} = \text{< NULL >}$ ;

end if

```

         $k = k + 1;$ 
    end for
end for
 $k = 0;$ 
for  $j = 0$  to  $T - 1$ 
    for  $i = 0$  to  $T - 1 - j$ 
        if  $v_{i,j} \neq \text{NULL}$ 
             $f_k = v_{i,j};$ 
             $k = k + 1$ 
        end if
    end for
end for
else
    for  $i = 0$  to  $E - 1$ 
         $f_i = e_i;$ 
    end for
end if

```

The value of  $E$  is no larger than 8192.

## 5.4.2 Rate matching for LDPC code

The rate matching for LDPC code is defined per coded block and consists of bit selection and bit interleaving. The input bit sequence to rate matching is  $d_0, d_1, d_2, \dots, d_{N-1}$ . The output bit sequence after rate matching is denoted as

$f_0, f_1, f_2, \dots, f_{E-1}$ .

### 5.4.2.1 Bit selection

The bit sequence after encoding  $d_0, d_1, d_2, \dots, d_{N-1}$  from Clause 5.3.2 is written into a circular buffer of length  $N_{cb}$  for the  $r$ -th coded block, where  $N$  is defined in Clause 5.3.2.

For the  $r$ -th code block, let  $N_{cb} = N$  if  $I_{LBRM} = 0$  and  $N_{cb} = \min(N, N_{ref})$  otherwise, where  $N_{ref} = \left\lfloor \frac{TBS_{LBRM}}{C \cdot R_{LBRM}} \right\rfloor$ ,

$R_{LBRM} = 2/3$ ,  $TBS_{LBRM}$  is determined according to Clause 6.1.4.2 in [6, TS 38.214] for UL-SCH and Clause 5.1.3.2 in [6, TS 38.214] for DL-SCH/PCH, assuming the following:

For one TB for DL-SCH with PDSCH scheduled by DCI format 4\_0/4\_1/4\_2,

- if the PDSCH is scheduled by DCI format 4\_1/4\_2,
- maximum number of layers is given by  $X$ , where
  - if the higher layer parameter *maxMIMO-Layers* of *pdsch-ConfigMulticast* is configured,  $X$  is given by that parameter;

- otherwise, X equals to 1;
- if the higher layer parameter *mcs-Table* given by a *pdsch-ConfigMulticast* for at least one common frequency resource (CFR) is set to 'qam256', maximum modulation order  $Q_m = 8$  is assumed for DL-SCH; otherwise a maximum modulation order  $Q_m = 6$  is assumed for DL-SCH;
- if the PDSCH is scheduled by DCI format 4\_0,
  - maximum number of layers is 1;
  - if the higher layer parameter *mcs-Table* given by a *pdsch-ConfigMCCH* is set to 'qam256', maximum modulation order  $Q_m = 8$  is assumed for DL-SCH; otherwise a maximum modulation order  $Q_m = 6$  is assumed for DL-SCH;
  - if the higher layer parameter *mcs-Table* given by a *pdsch-ConfigMTCH* is set to 'qam256', maximum modulation order  $Q_m = 8$  is assumed for DL-SCH; otherwise a maximum modulation order  $Q_m = 6$  is assumed for DL-SCH;
- $n_{PRB} = n_{PRB,LBRM}$  is given by Table 5.4.2.1-1, where the value of  $n_{PRB,LBRM}$  for DL-SCH is determined according to the size of the associated CFR if configured to the UE;
- maximum coding rate of 948/1024;
- $N_{RE} = 156 \cdot n_{PRB}$ ;
- C is the number of code blocks of the transport block determined according to Clause 5.2.2.

For one TB for UL-SCH, or for one TB for DL-SCH/PCH except for DL-SCH with PDSCH scheduled by DCI format 4\_0/4\_1/4\_2,

- maximum number of layers for one TB for UL-SCH is given by X, where
  - if the higher layer parameter *maxMIMO-Layers* of *PUSCH-ServingCellConfig* of the serving cell is configured, X is given by that parameter
  - elseif the higher layer parameter *maxRank* of *pusch-Config* of the serving cell is configured, X is given by the maximum value of *maxRank* across all BWPs of the serving cell
  - otherwise, X is given by the maximum number of layers for PUSCH supported by the UE for the serving cell
- maximum number of layers for one TB for DL-SCH/PCH is given by the minimum of X and 4, where
  - if the higher layer parameter *maxMIMO-Layers* of *PDSCH-ServingCellConfig* of the serving cell is configured, X is given by that parameter
  - otherwise, X is given by the maximum number of layers for PDSCH supported by the UE for the serving cell
- if the higher layer parameter *mcs-Table-r17* or *mcs-TableDCI-1-2-r17* given by a *pdsch-Config* for at least one DL BWP of the serving cell is set to 'qam1024', maximum modulation order  $Q_m = 10$  is assumed for DL-SCH, except if the UE indicated support for *pdsch-1024QAM-2MIMO-FR1-r17* and  $X > 2$ , maximum modulation order  $Q_m = 8$  is assumed for DL-SCH, else if the higher layer parameter *mcs-Table* or *mcs-TableDCI-1-2* given by a *pdsch-Config* for at least one DL BWP of the serving cell is set to 'qam256', maximum modulation order  $Q_m = 8$  is assumed for DL-SCH; otherwise a maximum modulation order  $Q_m = 6$  is assumed for DL-SCH;
- if the higher layer parameter *mcs-Table* or *mcs-TableTransformPrecoder* or *mcs-TableDCI-0-2* or *mcs-TableTransformPrecoderDCI-0-2* given by a *pusch-Config* or the higher layer parameter *mcs-Table* or *mcs-TableTransformPrecoder* given by *configuredGrantConfig* for at least one UL BWP of the serving cell is set to 'qam256', maximum modulation order  $Q_m = 8$  is assumed for UL-SCH; otherwise a maximum modulation order  $Q_m = 6$  is assumed for UL-SCH
- maximum coding rate of 948/1024;



- $n_{PRB} = n_{PRB,LBRM}$  is given by Table 5.4.2.1-1, where the value of  $n_{PRB,LBRM}$  for DL-SCH is determined according to the initial downlink bandwidth part if there is no other downlink bandwidth part configured to the UE;
- $N_{RE} = 156 \cdot n_{PRB}$ ;
- $C$  is the number of code blocks of the transport block determined according to Clause 5.2.2.

**Table 5.4.2.1-1: Value of  $n_{PRB,LBRM}$** 

| Maximum number of PRBs across all configured DL BWPs and UL BWPs of a carrier for DL-SCH and UL-SCH, respectively,<br>or<br>Maximum number of PRBs across all CFRs of a carrier for DL-SCH with PDSCH scheduled by DCI format 4_0/4_1/4_2 | $n_{PRB,LBRM}$ |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Less than 33                                                                                                                                                                                                                              | 32             |
| 33 to 66                                                                                                                                                                                                                                  | 66             |
| 67 to 107                                                                                                                                                                                                                                 | 107            |
| 108 to 135                                                                                                                                                                                                                                | 135            |
| 136 to 162                                                                                                                                                                                                                                | 162            |
| 163 to 217                                                                                                                                                                                                                                | 217            |
| Larger than 217                                                                                                                                                                                                                           | 273            |

Denoting by  $E_r$  the rate matching output sequence length for the  $r$ -th coded block, where the value of  $E_r$  is determined as follows:

Set  $j = 0$

for  $r = 0$  to  $C - 1$

if the  $r$ -th coded block is not scheduled for transmission as indicated by CBGTI according to Clause 5.1.7.2 for DL-SCH and 6.1.5.2 for UL-SCH in [6, TS 38.214]

$E_r = 0$ ;

else

if  $j \leq C' - \text{mod}(G / (N_L \cdot Q_m), C') - 1$

$$E_r = N_L \cdot Q_m \cdot \left\lfloor \frac{G}{N_L \cdot Q_m \cdot C'} \right\rfloor;$$

else

$$E_r = N_L \cdot Q_m \cdot \left\lceil \frac{G}{N_L \cdot Q_m \cdot C'} \right\rceil;$$

end if

$j = j + 1$ ;

end if

end for

where

- $N_L$  is the number of transmission layers that the transport block is mapped onto;

- $Q_m$  is the modulation order;
- $G$  is the total number of coded bits available for transmission of the transport block;
- $C' = C$  if CBGTI is not present in the DCI scheduling the transport block and  $C'$  is the number of scheduled code blocks of the transport block if CBGTI is present in the DCI scheduling the transport block.

Denote by  $rv_{id}$  the redundancy version number for this transmission ( $rv_{id} = 0, 1, 2$  or  $3$ ), the rate matching output bit sequence  $e_k$ ,  $k = 0, 1, 2, \dots, E-1$ , is generated as follows, where  $k_0$  is given by Table 5.4.2.1-2 according to the value of  $rv_{id}$  and LDPC base graph:

$k = 0$ ;

$j = 0$ ;

while  $k < E$

if  $d_{(k_0+j) \bmod N_{cb}} \neq \text{NULL}$

$e_k = d_{(k_0+j) \bmod N_{cb}}$ ;

$k = k + 1$ ;

end if

$j = j + 1$ ;

end while

**Table 5.4.2.1-2: Starting position of different redundancy versions,  $k_0$**

| $rv_{id}$ | $k_0$                                                   |                                                         |
|-----------|---------------------------------------------------------|---------------------------------------------------------|
|           | LDPC base graph 1                                       | LDPC base graph 2                                       |
| 0         | 0                                                       | 0                                                       |
| 1         | $\left\lfloor \frac{17N_{cb}}{66Z_c} \right\rfloor Z_c$ | $\left\lfloor \frac{13N_{cb}}{50Z_c} \right\rfloor Z_c$ |
| 2         | $\left\lfloor \frac{33N_{cb}}{66Z_c} \right\rfloor Z_c$ | $\left\lfloor \frac{25N_{cb}}{50Z_c} \right\rfloor Z_c$ |
| 3         | $\left\lfloor \frac{56N_{cb}}{66Z_c} \right\rfloor Z_c$ | $\left\lfloor \frac{43N_{cb}}{50Z_c} \right\rfloor Z_c$ |

#### 5.4.2.2 Bit interleaving

The bit sequence  $e_0, e_1, e_2, \dots, e_{E-1}$  is interleaved to bit sequence  $f_0, f_1, f_2, \dots, f_{E-1}$ , according to the following, where the value of  $Q_m$  is the modulation order.

for  $j = 0$  to  $E/Q_m - 1$

for  $i = 0$  to  $Q_m - 1$

$f_{i+j \cdot Q_m} = e_{i \cdot E/Q_m + j}$ ;

end for

end for

### 5.4.3 Rate matching for channel coding of small block lengths

The input bit sequence to rate matching is  $d_0, d_1, d_2, \dots, d_{N-1}$ . The output bit sequence after rate matching is denoted as  $f_0, f_1, f_2, \dots, f_{E-1}$ , where  $E$  is the rate matching output sequence length. The bit sequence  $f_0, f_1, f_2, \dots, f_{E-1}$  is obtained by the following:

for  $k=0$  to  $E-1$

$$f_k = d_{k \bmod N};$$

end for

## 5.5 Code block concatenation

The input bit sequence for the code block concatenation block are the sequences  $f_{rk}$ , for  $r = 0, \dots, C-1$  and  $k = 0, \dots, E_r - 1$ , where  $E_r$  is the number of rate matched bits for the  $r$ -th code block. The output bit sequence from the code block concatenation block is the sequence  $g_k$  for  $k = 0, \dots, G-1$ .

The code block concatenation consists of sequentially concatenating the rate matching outputs for the different code blocks. Therefore,

Set  $k = 0$  and  $r = 0$

while  $r < C$

Set  $j = 0$

while  $j < E_r$

$$g_k = f_{rj}$$

$$k = k + 1$$

$$j = j + 1$$

end while

$$r = r + 1$$

end while

---

## 6 Uplink transport channels and control information

### 6.1 Random access channel

The sequence index for the random access channel is received from higher layers and is processed according to [4, TS 38.211].

## 6.2 Uplink shared channel

### 6.2.1 Transport block CRC attachment

Error detection is provided on each UL-SCH transport block through a Cyclic Redundancy Check (CRC).

The entire transport block is used to calculate the CRC parity bits. Denote the bits in a transport block delivered to layer 1 by  $a_0, a_1, a_2, a_3, \dots, a_{A-1}$ , and the parity bits by  $p_0, p_1, p_2, p_3, \dots, p_{L-1}$ , where  $A$  is the payload size and  $L$  is the number of parity bits. The lowest order information bit  $a_0$  is mapped to the most significant bit of the transport block as defined in Clause 6.1.1 of [TS38.321].

The parity bits are computed and attached to the UL-SCH transport block according to Clause 5.1, by setting  $L$  to 24 bits and using the generator polynomial  $g_{\text{CRC24A}}(D)$  if  $A > 3824$ ; and by setting  $L$  to 16 bits and using the generator polynomial  $g_{\text{CRC16}}(D)$  otherwise.

The bits after CRC attachment are denoted by  $b_0, b_1, b_2, b_3, \dots, b_{B-1}$ , where  $B = A + L$ .

### 6.2.2 LDPC base graph selection

For initial transmission of a transport block with coding rate  $R$  indicated by the MCS index according to Clause 6.1.4.1 in [6, TS 38.214] and subsequent re-transmission of the same transport block, each code block of the transport block is encoded with either LDPC base graph 1 or 2 according to the following:

- if  $A \leq 292$ , or if  $A \leq 3824$  and  $R \leq 0.67$ , or if  $R \leq 0.25$ , LDPC base graph 2 is used;
- otherwise, LDPC base graph 1 is used,

where  $A$  is the payload size as described in Clause 6.2.1.

### 6.2.3 Code block segmentation and code block CRC attachment

The bits input to the code block segmentation are denoted by  $b_0, b_1, b_2, b_3, \dots, b_{B-1}$  where  $B$  is the number of bits in the transport block (including CRC).

Code block segmentation and code block CRC attachment are performed according to Clause 5.2.2.

The bits after code block segmentation are denoted by  $c_{r0}, c_{r1}, c_{r2}, c_{r3}, \dots, c_{r(K_r-1)}$ , where  $r$  is the code block number and  $K_r$  is the number of bits for code block number  $r$  according to Clause 5.2.2.

When the value of *numberOfSlotsTBoMS* in the row indicated by the Time domain resource assignment field in DCI is larger than 1, the value of  $B$  is no larger than 3840 if  $R \leq 0.25$  and no larger than 8448 otherwise, where coding rate  $R$  is indicated by the MCS index according to Clause 6.1.4.1 in [6, TS 38.214].

### 6.2.4 Channel coding of UL-SCH

Code blocks are delivered to the channel coding block. The bits in a code block are denoted by

$c_{r0}, c_{r1}, c_{r2}, c_{r3}, \dots, c_{r(K_r-1)}$ , where  $r$  is the code block number, and  $K_r$  is the number of bits in code block number  $r$ .

The total number of code blocks is denoted by  $C$  and each code block is individually LDPC encoded according to Clause 5.3.2.

After encoding the bits are denoted by  $d_{r0}, d_{r1}, d_{r2}, d_{r3}, \dots, d_{r(N_r-1)}$ , where the values of  $N_r$  is given in Clause 5.3.2.

## 6.2.5 Rate matching

Coded bits for each code block, denoted as  $d_{r0}, d_{r1}, d_{r2}, d_{r3}, \dots, d_{r(N_r-1)}$ , are delivered to the rate match block, where  $r$  is the code block number, and  $N_r$  is the number of encoded bits in code block number  $r$ . The total number of code blocks is denoted by  $C$  and each code block is individually rate matched according to Clause 5.4.2 by setting  $I_{LBRM} = 1$  if higher layer parameter *rateMatching* is set to *limitedBufferRM* and by setting  $I_{LBRM} = 0$  otherwise, if *numberOfSlotsTBoMS* is not present in the resource allocation table, or if *numberOfSlotsTBoMS* is present in the resource allocation table and the value of *numberOfSlotsTBoMS* in the row indicated by the Time domain resource assignment field in DCI is equal to 1. When the value of *numberOfSlotsTBoMS* in the row indicated by the Time domain resource assignment field in DCI is larger than 1, each code block is individually rate matched per slot according to Clause 5.4.2 by setting

- $I_{LBRM} = 1$  if higher layer parameter *rateMatching* is set to *limitedBufferRM* and by setting  $I_{LBRM} = 0$  otherwise;
- $G$  as the total number of coded bits available for transmission of the transport block in the slot;
- $k_0$  as given by Table 5.4.2.1-2 according to the value of *rvId* and LDPC base graph if the slot is the first slot within the  $N_s$  slots allocated for the transmission of TB processing over multiple slots, and setting  $k_0 = (k'_0 + H + \tau) \bmod N_{cb}$  if the slot is a slot except for the first one within the  $N_s$  slots, where  $N_s$  is the value of *numberOfSlotsTBoMS* in the row indicated by the Time domain resource assignment field in DCI,  $k'_0$  denotes the index of starting coded bit in the previous slot within the  $N_s$  slots,  $H$  is the total number of coded bits available for transmission of the transport block in the previous slot within the  $N_s$  slots assuming no UCI multiplexing, and  $\tau$  denotes the number of skipped filler bits if any in the previous slot within the  $N_s$  slots according to Clause 5.4.2.1 by assuming no UCI multiplexing.

After rate matching, the bits are denoted by  $f_{r0}, f_{r1}, f_{r2}, f_{r3}, \dots, f_{r(E_r-1)}$ , where  $E_r$  is the number of rate matched bits for code block number  $r$ .

## 6.2.6 Code block concatenation

The input bit sequence for the code block concatenation block are the sequences  $f_{r0}, f_{r1}, f_{r2}, f_{r3}, \dots, f_{r(E_r-1)}$ , for  $r = 0, \dots, C-1$  and where  $E_r$  is the number of rate matched bits for the  $r$ -th code block.

Code block concatenation is performed according to Clause 5.5.

The bits after code block concatenation are denoted by  $g_0, g_1, g_2, g_3, \dots, g_{G-1}$ , where  $G$  is the total number of coded bits for transmission.

## 6.2.7 Data and control multiplexing

Denote the coded bits for UL-SCH as  $g_0^{\text{UL-SCH}}, g_1^{\text{UL-SCH}}, g_2^{\text{UL-SCH}}, g_3^{\text{UL-SCH}}, \dots, g_{G^{\text{UL-SCH}}-1}^{\text{UL-SCH}}$ .

Denote the coded bits for HARQ-ACK or jointly coded bits for HARQ-ACK and CG-UCI when the high layer parameter *cg-UCI-Multiplexing* is configured, if any, as  $g_0^{\text{ACK}}, g_1^{\text{ACK}}, g_2^{\text{ACK}}, g_3^{\text{ACK}}, \dots, g_{G^{\text{ACK}}-1}^{\text{ACK}}$ .

Denote the coded bits for CSI part 1, if any, as  $g_0^{\text{CSI-part1}}, g_1^{\text{CSI-part1}}, g_2^{\text{CSI-part1}}, g_3^{\text{CSI-part1}}, \dots, g_{G^{\text{CSI-part1}}-1}^{\text{CSI-part1}}$ .

Denote the coded bits for CSI part 2, if any, as  $g_0^{\text{CSI-part2}}, g_1^{\text{CSI-part2}}, g_2^{\text{CSI-part2}}, g_3^{\text{CSI-part2}}, \dots, g_{G^{\text{CSI-part2}}-1}^{\text{CSI-part2}}$ .

Denote the coded bits for CG-UCI without HARQ-ACK, if any, as  $g_0^{\text{CG-UCI}}, g_1^{\text{CG-UCI}}, g_2^{\text{CG-UCI}}, g_3^{\text{CG-UCI}}, \dots, g_{G^{\text{CG-UCI}}-1}^{\text{CG-UCI}}$ .

Denote the multiplexed data and control coded bit sequence as  $g_0, g_1, g_2, g_3, \dots, g_{G-1}$ .

Denote  $l$  as the OFDM symbol index of the scheduled PUSCH, starting from 0 to  $N_{\text{symb,all}}^{\text{PUSCH}} - 1$ , where  $N_{\text{symb,all}}^{\text{PUSCH}}$  is the total number of OFDM symbols of the PUSCH, including all OFDM symbols used for DMRS.

Denote  $k$  as the subcarrier index of the scheduled PUSCH, starting from 0 to  $M_{sc}^{PUSCH} - 1$ , where  $M_{sc}^{PUSCH}$  is expressed as a number of subcarriers.

Denote  $\Phi_l^{UL-SCH}$  as the set of resource elements, in ascending order of indices  $k$ , available for transmission of data in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{\text{symb,all}}^{PUSCH} - 1$ .

Denote  $M_{sc}^{UL-SCH}(l) = |\Phi_l^{UL-SCH}|$  as the number of elements in set  $\Phi_l^{UL-SCH}$ . Denote  $\Phi_l^{UL-SCH}(j)$  as the  $j$ -th element in  $\Phi_l^{UL-SCH}$ .

Denote  $\Phi_l^{UCI}$  as the set of resource elements, in ascending order of indices  $k$ , available for transmission of UCI in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{\text{symb,all}}^{PUSCH} - 1$ . Denote  $M_{sc}^{UCI}(l) = |\Phi_l^{UCI}|$  as the number of elements in set  $\Phi_l^{UCI}$ . Denote  $\Phi_l^{UCI}(j)$  as the  $j$ -th element in  $\Phi_l^{UCI}$ . For any OFDM symbol that carries DMRS of the PUSCH,  $\Phi_l^{UCI} = \emptyset$ . For any OFDM symbol that does not carry DMRS of the PUSCH,  $\Phi_l^{UCI} = \Phi_l^{UL-SCH}$ .

If frequency hopping is configured for the PUSCH,

- denote  $l^{(1)}$  as the OFDM symbol index of the first OFDM symbol after the first set of consecutive OFDM symbol(s) carrying DMRS in the first hop;
- denote  $l^{(2)}$  as the OFDM symbol index of the first OFDM symbol after the first set of consecutive OFDM symbol(s) carrying DMRS in the second hop.
- denote  $l_{\text{CSI}}^{(1)}$  as the OFDM symbol index of the first OFDM symbol that does not carry DMRS in the first hop;
- denote  $l_{\text{CSI}}^{(2)}$  as the OFDM symbol index of the first OFDM symbol that does not carry DMRS in the second hop;
- if HARQ-ACK is present for transmission on the PUSCH with UL-SCH or if both HARQ-ACK and CG-UCI are present on the same PUSCH with UL-SCH, let
  - $G^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \lfloor G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor$  and  $G^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \lceil G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$ ;
- if CSI is present for transmission on the PUSCH with UL-SCH, let
  - $G^{\text{CSI-part1}}(1) = N_L \cdot Q_m \cdot \lfloor G^{\text{CSI-part1}} / (2 \cdot N_L \cdot Q_m) \rfloor$ ;
  - $G^{\text{CSI-part1}}(2) = N_L \cdot Q_m \cdot \lceil G^{\text{CSI-part1}} / (2 \cdot N_L \cdot Q_m) \rceil$ ;
  - $G^{\text{CSI-part2}}(1) = N_L \cdot Q_m \cdot \lfloor G^{\text{CSI-part2}} / (2 \cdot N_L \cdot Q_m) \rfloor$ ; and
  - $G^{\text{CSI-part2}}(2) = N_L \cdot Q_m \cdot \lceil G^{\text{CSI-part2}} / (2 \cdot N_L \cdot Q_m) \rceil$ ;
- if CG-UCI is present for transmission on the PUSCH with UL-SCH and without HARQ-ACK, let
  - $G^{\text{CG-UCI}}(1) = N_L \cdot Q_m \cdot \lfloor G^{\text{CG-UCI}} / (2 \cdot N_L \cdot Q_m) \rfloor$  and  $G^{\text{CG-UCI}}(2) = N_L \cdot Q_m \cdot \lceil G^{\text{CG-UCI}} / (2 \cdot N_L \cdot Q_m) \rceil$
- if only HARQ-ACK and CSI part 1 are present for transmission on the PUSCH without UL-SCH, let
  - $G^{\text{ACK}}(1) = \min(N_L \cdot Q_m \cdot \lfloor G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor, M_3 \cdot N_L \cdot Q_m)$ ;
  - $G^{\text{ACK}}(2) = G^{\text{ACK}} - G^{\text{ACK}}(1)$ ;
  - $G^{\text{CSI-part1}}(1) = M_1 \cdot N_L \cdot Q_m - G^{\text{ACK}}(1)$ ; and
  - $G^{\text{CSI-part1}}(2) = G^{\text{CSI-part1}} - G^{\text{CSI-part1}}(1)$ ;

- if HARQ-ACK, CSI part 1 and CSI part 2 are present for transmission on the PUSCH without UL-SCH, let
  - $G^{\text{ACK}}(1) = \min\left(N_L \cdot Q_m \cdot \left\lfloor G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \right\rfloor, M_3 \cdot N_L \cdot Q_m\right);$
  - $G^{\text{ACK}}(2) = G^{\text{ACK}} - G^{\text{ACK}}(1);$
  - if the number of HARQ-ACK information bits is more than 2,  
 $G^{\text{CSI-part1}}(1) = \min\left(N_L \cdot Q_m \cdot \left\lfloor G^{\text{CSI-part1}} / (2 \cdot N_L \cdot Q_m) \right\rfloor, M_1 \cdot N_L \cdot Q_m - G^{\text{ACK}}(1)\right);$  otherwise,  
 $G^{\text{CSI-part1}}(1) = \min\left(N_L \cdot Q_m \cdot \left\lfloor G^{\text{CSI-part1}} / (2 \cdot N_L \cdot Q_m) \right\rfloor, M_1 \cdot N_L \cdot Q_m - G_{\text{rvd}}^{\text{ACK}}(1)\right)$
  - $G^{\text{CSI-part1}}(2) = G^{\text{CSI-part1}} - G^{\text{CSI-part1}}(1);$
  - $G^{\text{CSI-part2}}(1) = M_2 \cdot N_L \cdot Q_m - G^{\text{CSI-part1}}(1)$  if the number of HARQ-ACK information bits is no more than 2, and  
 $G^{\text{CSI-part2}}(1) = M_2 \cdot N_L \cdot Q_m - G^{\text{ACK}}(1) - G^{\text{CSI-part1}}(1)$  otherwise; and
  - $G^{\text{CSI-part2}}(2) = M_2 \cdot N_L \cdot Q_m - G^{\text{CSI-part1}}(2)$  if the number of HARQ-ACK information bits is no more than 2, and  
 $G^{\text{CSI-part2}}(2) = M_2 \cdot N_L \cdot Q_m - G^{\text{ACK}}(2) - G^{\text{CSI-part1}}(2)$  otherwise;
- if only CSI part 1 and CSI part 2 are present for transmission on the PUSCH without UL-SCH, let
  - $G^{\text{CSI-part1}}(1) = \min\left(N_L \cdot Q_m \cdot \left\lfloor G^{\text{CSI-part1}} / (2 \cdot N_L \cdot Q_m) \right\rfloor, M_1 \cdot N_L \cdot Q_m - G_{\text{rvd}}^{\text{ACK}}(1)\right);$
  - $G^{\text{CSI-part1}}(2) = G^{\text{CSI-part1}} - G^{\text{CSI-part1}}(1);$
  - $G^{\text{CSI-part2}}(1) = M_2 \cdot N_L \cdot Q_m - G^{\text{CSI-part1}}(1);$  and
  - $G^{\text{CSI-part2}}(2) = M_2 \cdot N_L \cdot Q_m - G^{\text{CSI-part1}}(2);$
- let  $N_{\text{hop}}^{\text{PUSCH}} = 2$ , and denote  $N_{\text{sybm,hop}}^{\text{PUSCH}}(1)$ ,  $N_{\text{sybm,hop}}^{\text{PUSCH}}(2)$  as the number of OFDM symbols of the PUSCH in the first and second hop, respectively;
- $N_L$  is the number of transmission layers of the PUSCH;
- $Q_m$  is the modulation order of the PUSCH;

$$M_1 = \sum_{l=0}^{N_{\text{sybm,hop}}^{\text{PUSCH}}(1)-1} M_{\text{SC}}^{\text{UCI}}(l);$$

$$M_2 = \sum_{l=N_{\text{sybm,hop}}^{\text{PUSCH}}(1)}^{N_{\text{sybm,hop}}^{\text{PUSCH}}(1)+N_{\text{sybm,hop}}^{\text{PUSCH}}(2)-1} M_{\text{SC}}^{\text{UCI}}(l)$$

$$M_3 = \sum_{l=l^{(1)}}^{N_{\text{sybm,hop}}^{\text{PUSCH}}(1)-1} M_{\text{SC}}^{\text{UCI}}(l).$$

If frequency hopping is not configured for the PUSCH,

- denote  $l^{(1)}$  as the OFDM symbol index of the first OFDM symbol after the first set of consecutive OFDM symbol(s) carrying DMRS;
- denote  $l_{\text{CSI}}^{(1)}$  as the OFDM symbol index of the first OFDM symbol that does not carry DMRS;
- if HARQ-ACK is present for transmission on the PUSCH or if both HARQ-ACK and CG-UCI are present on the same PUSCH with UL-SCH, let  $G^{\text{ACK}}(1) = G^{\text{ACK}};$
- if CSI is present for transmission on the PUSCH, let  $G^{\text{CSI-part1}}(1) = G^{\text{CSI-part1}}$  and  $G^{\text{CSI-part2}}(1) = G^{\text{CSI-part2}};$

- if CG-UCI is present for transmission on the PUSCH without HARQ-ACK, let  $G^{\text{CG-UCI}}(1) = G^{\text{CG-UCI}}$ ;
- let  $N_{\text{hop}}^{\text{PUSCH}} = 1$  and  $N_{\text{symb,hop}}^{\text{PUSCH}}(1) = N_{\text{symb,all}}^{\text{PUSCH}}$ .

The multiplexed data and control coded bit sequence  $g_0, g_1, g_2, g_3, \dots, g_{G-1}$  is obtained according to the following:

**Step 1:**

Set  $\bar{\Phi}_l^{\text{UL-SCH}} = \Phi_l^{\text{UL-SCH}}$  for  $l = 0, 1, 2, \dots, N_{\text{symb,all}}^{\text{PUSCH}} - 1$ ;

Set  $\bar{M}_{\text{sc}}^{\text{UL-SCH}}(l) = |\bar{\Phi}_l^{\text{UL-SCH}}|$  for  $l = 0, 1, 2, \dots, N_{\text{symb,all}}^{\text{PUSCH}} - 1$ ;

Set  $\bar{\Phi}_l^{\text{UCI}} = \Phi_l^{\text{UCI}}$  for  $l = 0, 1, 2, \dots, N_{\text{symb,all}}^{\text{PUSCH}} - 1$ ;

Set  $\bar{M}_{\text{sc}}^{\text{UCI}}(l) = |\bar{\Phi}_l^{\text{UCI}}|$  for  $l = 0, 1, 2, \dots, N_{\text{symb,all}}^{\text{PUSCH}} - 1$ ;

if the number of HARQ-ACK information bits to be transmitted on PUSCH is 0, 1 or 2 bits and without CG-UCI

the number of reserved resource elements for potential HARQ-ACK transmission is calculated according to Clause 6.3.2.4.2.1, by setting  $O_{\text{ACK}} = 2$ ;

denote  $G_{\text{rvd}}^{\text{ACK}}$  as the number of coded bits for potential HARQ-ACK transmission using the reserved resource elements;

if frequency hopping is configured for the PUSCH, let  $G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor$  and

$$G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil;$$

if frequency hopping is not configured for the PUSCH, let  $G_{\text{rvd}}^{\text{ACK}}(1) = G_{\text{rvd}}^{\text{ACK}}$ ;

denote  $\bar{\Phi}_l^{\text{rvd}}$  as the set of reserved resource elements for potential HARQ-ACK transmission, in OFDM symbol  $l$ ,  
for  $l = 0, 1, 2, \dots, N_{\text{symb,all}}^{\text{PUSCH}} - 1$ ;

Set  $m_{\text{count}}^{\text{ACK}}(1) = 0$ ;

Set  $m_{\text{count}}^{\text{ACK}}(2) = 0$ ;

$\bar{\Phi}_l^{\text{rvd}} = \emptyset$  for  $l = 0, 1, 2, \dots, N_{\text{symb,all}}^{\text{PUSCH}} - 1$ ;

for  $i = 1$  to  $N_{\text{hop}}^{\text{PUSCH}}$

$$l = l^{(i)};$$

while  $m_{\text{count}}^{\text{ACK}}(i) < G_{\text{rvd}}^{\text{ACK}}(i)$

if  $\bar{M}_{\text{sc}}^{\text{UCI}}(l) > 0$

if  $G_{\text{rvd}}^{\text{ACK}}(i) - m_{\text{count}}^{\text{ACK}}(i) \geq \bar{M}_{\text{sc}}^{\text{UCI}}(l) \cdot N_L \cdot Q_m$

$$d = 1;$$

$$m_{\text{count}}^{\text{RE}} = \bar{M}_{\text{sc}}^{\text{UL-SCH}}(l);$$

end if



if  $G_{\text{rvd}}^{\text{ACK}}(i) - m_{\text{count}}^{\text{ACK}}(i) < \bar{M}_{\text{sc}}^{\text{UCI}}(l) \cdot N_L \cdot Q_m$   

$$d = \left\lfloor \bar{M}_{\text{sc}}^{\text{UCI}}(l) \cdot N_L \cdot Q_m / (G_{\text{rvd}}^{\text{ACK}}(i) - m_{\text{count}}^{\text{ACK}}(i)) \right\rfloor;$$
  

$$m_{\text{count}}^{\text{RE}} = \left\lceil (G_{\text{rvd}}^{\text{ACK}}(i) - m_{\text{count}}^{\text{ACK}}(i)) / (N_L \cdot Q_m) \right\rceil;$$
  
 end if  
 for  $j = 0$  to  $m_{\text{count}}^{\text{RE}} - 1$   

$$\bar{\Phi}_l^{\text{rvd}} = \bar{\Phi}_l^{\text{rvd}} \cup \{\bar{\Phi}_l^{\text{UL-SCH}}(j \cdot d)\}$$
  

$$m_{\text{count}}^{\text{ACK}}(i) = m_{\text{count}}^{\text{ACK}}(i) + N_L \cdot Q_m;$$
  
 end for  
 end if  
 $l = l + 1;$   
 end while  
 end for

else

$\bar{\Phi}_l^{\text{rvd}} = \emptyset$  for  $l = 0, 1, 2, \dots, N_{\text{symbol,all}}^{\text{PUSCH}} - 1;$

end if

Denote  $\bar{M}_{\text{sc,rvd}}^{\bar{\Phi}}(l) = |\bar{\Phi}_l^{\text{rvd}}|$  as the number of elements in  $\bar{\Phi}_l^{\text{rvd}}$ .

### **Step 2:**

if HARQ-ACK is present for transmission on the PUSCH and the number of HARQ-ACK information bits is more than 2 or if both HARQ-ACK and CG-UCI are present on the same PUSCH with UL-SCH,

Set  $m_{\text{count}}^{\text{ACK}}(1) = 0;$

Set  $m_{\text{count}}^{\text{ACK}}(2) = 0;$

Set  $m_{\text{count,all}}^{\text{ACK}} = 0;$

for  $i = 1$  to  $N_{\text{hop}}^{\text{PUSCH}}$

$l = l^{(i)};$

while  $m_{\text{count}}^{\text{ACK}}(i) < G^{\text{ACK}}(i)$

if  $\bar{M}_{\text{sc}}^{\text{UCI}}(l) > 0$

if  $G^{\text{ACK}}(i) - m_{\text{count}}^{\text{ACK}}(i) \geq \bar{M}_{\text{sc}}^{\text{UCI}}(l) \cdot N_L \cdot Q_m$

$d = 1;$

$$m_{\text{count}}^{\text{RE}} = \bar{M}_{\text{sc}}^{\text{UCI}}(l);$$

end if

$$\text{if } G^{\text{ACK}}(i) - m_{\text{count}}^{\text{ACK}}(i) < \bar{M}_{\text{sc}}^{\text{UCI}}(l) \cdot N_L \cdot Q_m$$

$$d = \left\lfloor \bar{M}_{\text{sc}}^{\text{UCI}}(l) \cdot N_L \cdot Q_m / (G^{\text{ACK}}(i) - m_{\text{count}}^{\text{ACK}}(i)) \right\rfloor;$$

$$m_{\text{count}}^{\text{RE}} = \left\lceil (G^{\text{ACK}}(i) - m_{\text{count}}^{\text{ACK}}(i)) / (N_L \cdot Q_m) \right\rceil;$$

end if

$$\text{for } j = 0 \text{ to } m_{\text{count}}^{\text{RE}} - 1$$

$$k = \bar{\Phi}_l^{\text{UCI}}(j \cdot d);$$

$$\text{for } v = 0 \text{ to } N_L \cdot Q_m - 1$$

$$\bar{g}_{l,k,v} = g_{m_{\text{count,all}}^{\text{ACK}}}^{\text{ACK}};$$

$$m_{\text{count,all}}^{\text{ACK}} = m_{\text{count,all}}^{\text{ACK}} + 1;$$

$$m_{\text{count}}^{\text{ACK}}(i) = m_{\text{count}}^{\text{ACK}}(i) + 1;$$

end for

end for

$$\bar{\Phi}_{l,\text{tmp}}^{\text{UCI}} = \emptyset;$$

$$\text{for } j = 0 \text{ to } m_{\text{count}}^{\text{RE}} - 1$$

$$\bar{\Phi}_{l,\text{tmp}}^{\text{UCI}} = \bar{\Phi}_{l,\text{tmp}}^{\text{UCI}} \cup \bar{\Phi}_l^{\text{UCI}}(j \cdot d);$$

end for

$$\bar{\Phi}_l^{\text{UCI}} = \bar{\Phi}_l^{\text{UCI}} \setminus \bar{\Phi}_{l,\text{tmp}}^{\text{UCI}};$$

$$\bar{\Phi}_l^{\text{UL-SCH}} = \bar{\Phi}_l^{\text{UL-SCH}} \setminus \bar{\Phi}_{l,\text{tmp}}^{\text{UCI}};$$

$$\bar{M}_{\text{sc}}^{\text{UCI}}(l) = |\bar{\Phi}_l^{\text{UCI}}|;$$

$$\bar{M}_{\text{sc}}^{\text{UL-SCH}}(l) = |\bar{\Phi}_l^{\text{UL-SCH}}|;$$

end if

$$l = l + 1;$$

end while

end for

end if

**Step 2A:**

If CG-UCI is present for transmission on the PUSCH without HARQ-ACK,

Set  $m_{count}^{CG-UCI}(1) = 0$ ;

Set  $m_{count}^{CG-UCI}(2) = 0$ ;

Set  $m_{count,all}^{CG-UCI} = 0$ ;

for  $i = 1$  to  $N_{hop}^{PUSCH}$

$l = l^{(i)}$ ;

while  $m_{count}^{CG-UCI}(i) < G^{CG-UCI}(i)$

if  $\bar{M}_{sc}^{UCI}(l) > 0$

if  $G^{CG-UCI}(i) - m_{count}^{CG-UCI}(1) \geq \bar{M}_{sc}^{UCI}(l) \cdot N_L \cdot Q_m$

$d = 1$ ;

$m_{count}^{RE} = \bar{M}_{sc}^{UCI}(l)$ ;

end if

if  $G^{CG-UCI}(i) - m_{count}^{CG-UCI}(1) < \bar{M}_{sc}^{UCI}(l) \cdot N_L \cdot Q_m$

$d = \lfloor \bar{M}_{sc}^{UCI}(l) \cdot N_L \cdot Q_m / (G^{CG-UCI}(i) - m_{count}^{CG-UCI}(i)) \rfloor$ ;

$m_{count}^{RE} = \lfloor (G^{CG-UCI}(i) - m_{count}^{CG-UCI}(i)) / (N_L \cdot Q_m) \rfloor$ ;

end if

for  $j = 0$  to  $m_{count}^{RE} - 1$

$k = \bar{\Phi}_l^{UCI}(j, d)$ ;

for  $v = 0$  to  $N_L \cdot Q_m - 1$

$\bar{g}_{l,k,v} = g_{m_{count,all}^{CG-UCI}}^{CG-UCI}$ ;

$m_{count,all}^{CG-UCI} = m_{count,all}^{CG-UCI} + 1$ ;

$m_{count}^{CG-UCI}(i) = m_{count}^{CG-UCI}(i) + 1$ ;

end for

end for

$\bar{\Phi}_{l,tmp}^{UCI} = \emptyset$ ;

for  $j = 0$  to  $m_{count}^{RE} - 1$

$\bar{\Phi}_{l,tmp}^{UCI} = \bar{\Phi}_{l,tmp}^{UCI} \cup \bar{\Phi}_l^{UCI}(j, d)$ ;

end for

$\bar{\Phi}_l^{UCI} = \bar{\Phi}_l^{UCI} \setminus \bar{\Phi}_{l,tmp}^{UCI}$ ;

$\bar{\Phi}_l^{UL-SCH} = \bar{\Phi}_l^{UL-SCH} \setminus \bar{\Phi}_{l,tmp}^{UCI}$ ;

$\bar{M}_{sc}^{UCI}(l) = |\bar{\Phi}_l^{UCI}|$ ;

$\bar{M}_{sc}^{UL-SCH}(l) = |\bar{\Phi}_l^{UL-SCH}|$ ;

end if

$l = l + 1;$

end while

end for

end if

### **Step 3:**

if CSI is present for transmission on the PUSCH,

Set  $m_{\text{count}}^{\text{CSI-part1}}(1) = 0;$

Set  $m_{\text{count}}^{\text{CSI-part1}}(2) = 0;$

Set  $m_{\text{count,all}}^{\text{CSI-part1}} = 0;$

for  $i = 1$  to  $N_{\text{hop}}^{\text{PUSCH}}$

$l = l_{\text{CSI}}^{(i)};$

while  $\bar{M}_{\text{sc}}^{\text{UCI}}(l) - \bar{M}_{\text{sc,rvd}}^{\Phi}(l) \leq 0$

$l = l + 1;$

end while

while  $m_{\text{count}}^{\text{CSI-part1}}(i) < G^{\text{CSI-part1}}(i)$

if  $\bar{M}_{\text{sc}}^{\text{UCI}}(l) - \bar{M}_{\text{sc,rvd}}^{\Phi}(l) > 0$

if  $G^{\text{CSI-part1}}(i) - m_{\text{count}}^{\text{CSI-part1}}(i) \geq (\bar{M}_{\text{sc}}^{\text{UCI}}(l) - \bar{M}_{\text{sc,rvd}}^{\Phi}(l)) \cdot N_L \cdot Q_m$

$d = 1;$

$m_{\text{count}}^{\text{RE}} = \bar{M}_{\text{sc}}^{\text{UCI}}(l) - \bar{M}_{\text{sc,rvd}}^{\Phi}(l);$

end if

if  $G^{\text{CSI-part1}}(i) - m_{\text{count}}^{\text{CSI-part1}}(i) < (\bar{M}_{\text{sc}}^{\text{UCI}}(l) - \bar{M}_{\text{sc,rvd}}^{\Phi}(l)) \cdot N_L \cdot Q_m$

$d = \left\lfloor (\bar{M}_{\text{sc}}^{\text{UCI}}(l) - \bar{M}_{\text{sc,rvd}}^{\Phi}(l)) \cdot N_L \cdot Q_m / (G^{\text{CSI-part1}}(i) - m_{\text{count}}^{\text{CSI-part1}}(i)) \right\rfloor;$

$m_{\text{count}}^{\text{RE}} = \left\lceil (G^{\text{CSI-part1}}(i) - m_{\text{count}}^{\text{CSI-part1}}(i)) / (N_L \cdot Q_m) \right\rceil;$

end if

$\bar{\Phi}_l^{\text{temp}} = \bar{\Phi}_l^{\text{UCI}} \setminus \bar{\Phi}_l^{\text{rvd}};$

for  $j = 0$  to  $m_{\text{count}}^{\text{RE}} - 1$

$k = \bar{\Phi}_l^{\text{temp}}(j \cdot d);$

for  $v = 0$  to  $N_L \cdot Q_m - 1$

$$\bar{g}_{l,k,v} = g_{m_{\text{count,all}}^{\text{CSI-part1}}};$$

$$m_{\text{count,all}}^{\text{CSI-part1}} = m_{\text{count,all}}^{\text{CSI-part1}} + 1;$$

$$m_{\text{count}}^{\text{CSI-part1}}(i) = m_{\text{count}}^{\text{CSI-part1}}(i) + 1;$$

end for

end for

$$\bar{\Phi}_{l,tmp}^{\text{UCI}} = \emptyset;$$

for  $j = 0$  to  $m_{\text{count}}^{\text{RE}} - 1$

$$\bar{\Phi}_{l,tmp}^{\text{UCI}} = \bar{\Phi}_{l,tmp}^{\text{UCI}} \cup \bar{\Phi}_l^{\text{temp}}(j \cdot d);$$

end for

$$\bar{\Phi}_l^{\text{UCI}} = \bar{\Phi}_l^{\text{UCI}} \setminus \bar{\Phi}_{l,tmp}^{\text{UCI}};$$

$$\bar{\Phi}_l^{\text{UL-SCH}} = \bar{\Phi}_l^{\text{UL-SCH}} \setminus \bar{\Phi}_{l,tmp}^{\text{UCI}};$$

$$\bar{M}_{\text{sc}}^{\text{UCI}}(l) = |\bar{\Phi}_l^{\text{UCI}}|;$$

$$\bar{M}_{\text{sc}}^{\text{UL-SCH}}(l) = |\bar{\Phi}_l^{\text{UL-SCH}}|;$$

end if

$$l = l + 1;$$

end while

end for

Set  $m_{\text{count}}^{\text{CSI-part2}}(1) = 0;$

Set  $m_{\text{count}}^{\text{CSI-part2}}(2) = 0;$

Set  $m_{\text{count,all}}^{\text{CSI-part2}} = 0;$

for  $i = 1$  to  $N_{\text{hop}}^{\text{PUSCH}}$

$$l = l_{\text{CSI}}^{(i)};$$

while  $\bar{M}_{\text{sc}}^{\text{UCI}}(l) \leq 0$

$$l = l + 1;$$

end while

while  $m_{\text{count}}^{\text{CSI-part2}}(i) < G^{\text{CSI-part2}}(i)$

if  $\bar{M}_{\text{sc}}^{\text{UCI}}(l) > 0$

if  $G^{\text{CSI-part2}}(i) - m_{\text{count}}^{\text{CSI-part2}}(i) \geq \bar{M}_{\text{sc}}^{\text{UCI}}(l) \cdot N_L \cdot Q_m$

$d = 1$ ;

$m_{\text{count}}^{\text{RE}} = \bar{M}_{\text{sc}}^{\text{UCI}}(l)$ ;

end if

if  $G^{\text{CSI-part2}}(i) - m_{\text{count}}^{\text{CSI-part2}}(i) < \bar{M}_{\text{sc}}^{\text{UCI}}(l) \cdot N_L \cdot Q_m$

$d = \left\lfloor \bar{M}_{\text{sc}}^{\text{UCI}}(l) \cdot N_L \cdot Q_m / (G^{\text{CSI-part2}}(i) - m_{\text{count}}^{\text{CSI-part2}}(i)) \right\rfloor$ ;

$m_{\text{count}}^{\text{RE}} = \left\lceil (G^{\text{CSI-part2}}(i) - m_{\text{count}}^{\text{CSI-part2}}(i)) / (N_L \cdot Q_m) \right\rceil$ ;

end if

for  $j = 0$  to  $m_{\text{count}}^{\text{RE}} - 1$

$k = \bar{\Phi}_l^{\text{UCI}}(j \cdot d)$ ;

for  $v = 0$  to  $N_L \cdot Q_m - 1$

$\bar{g}_{l,k,v} = g_{m_{\text{count,all}}^{\text{CSI-part2}}}$ ;

$m_{\text{count,all}}^{\text{CSI-part2}} = m_{\text{count,all}}^{\text{CSI-part2}} + 1$ ;

$m_{\text{count}}^{\text{CSI-part2}}(i) = m_{\text{count}}^{\text{CSI-part2}}(i) + 1$ ;

end for

end for

$\bar{\Phi}_{l,tmp}^{\text{UCI}} = \emptyset$ ;

for  $j = 0$  to  $m_{\text{count}}^{\text{RE}} - 1$

$\bar{\Phi}_{l,tmp}^{\text{UCI}} = \bar{\Phi}_{l,tmp}^{\text{UCI}} \cup \bar{\Phi}_l^{\text{UCI}}(j \cdot d)$ ;

end for

$\bar{\Phi}_l^{\text{UCI}} = \bar{\Phi}_l^{\text{UCI}} \setminus \bar{\Phi}_{l,tmp}^{\text{UCI}}$ ;

$\bar{\Phi}_l^{\text{UL-SCH}} = \bar{\Phi}_l^{\text{UL-SCH}} \setminus \bar{\Phi}_{l,tmp}^{\text{UCI}}$ ;

$\bar{M}_{\text{sc}}^{\text{UCI}}(l) = |\bar{\Phi}_l^{\text{UCI}}|$ ;

$\bar{M}_{\text{sc}}^{\text{UL-SCH}}(l) = |\bar{\Phi}_l^{\text{UL-SCH}}|$ ;

end if

$l = l + 1$ ;

end while

end for

end if

**Step 4:**

if UL-SCH is present for transmission on the PUSCH,

Set  $m_{\text{count}}^{\text{UL-SCH}} = 0$ ;

for  $l = 0$  to  $N_{\text{symb,all}}^{\text{PUSCH}} - 1$

if  $\bar{M}_{\text{sc}}^{\text{UL-SCH}}(l) > 0$

for  $j = 0$  to  $\bar{M}_{\text{sc}}^{\text{UL-SCH}}(l) - 1$

$k = \bar{\Phi}_l^{\text{UL-SCH}}(j)$ ;

for  $v = 0$  to  $N_L \cdot Q_m - 1$

$\bar{g}_{l,k,v} = g_{m_{\text{count}}^{\text{UL-SCH}}}^{\text{UL-SCH}}$ ;

$m_{\text{count}}^{\text{UL-SCH}} = m_{\text{count}}^{\text{UL-SCH}} + 1$ ;

end for

end for

end if

end for

end if

**Step 5:**

if HARQ-ACK is present for transmission on the PUSCH without CG-UCI and the number of HARQ-ACK information bits is no more than 2,

Set  $m_{\text{count}}^{\text{ACK}}(1) = 0$ ;

Set  $m_{\text{count}}^{\text{ACK}}(2) = 0$ ;

Set  $m_{\text{count,all}}^{\text{ACK}} = 0$ ;

for  $i = 1$  to  $N_{\text{hop}}^{\text{PUSCH}}$

$l = l^{(i)}$ ;

while  $m_{\text{count}}^{\text{ACK}}(i) < G^{\text{ACK}}(i)$

if  $\bar{M}_{\text{sc,rvd}}^{\bar{\Phi}}(l) > 0$

if  $G^{\text{ACK}}(i) - m_{\text{count}}^{\text{ACK}}(i) \geq \bar{M}_{\text{sc,rvd}}^{\bar{\Phi}}(l) \cdot N_L \cdot Q_m$

$d = 1$ ;

$$m_{\text{count}}^{\text{RE}} = \bar{M}_{\text{sc,rvd}}^{\Phi}(l);$$

end if

$$\text{if } G^{\text{ACK}}(i) - m_{\text{count}}^{\text{ACK}}(i) < \bar{M}_{\text{sc,rvd}}^{\Phi}(l) \cdot N_L \cdot Q_m$$

$$d = \left\lfloor \bar{M}_{\text{sc,rvd}}^{\Phi}(l) \cdot N_L \cdot Q_m / (G^{\text{ACK}}(i) - m_{\text{count}}^{\text{ACK}}(i)) \right\rfloor;$$

$$m_{\text{count}}^{\text{RE}} = \left\lceil (G^{\text{ACK}}(i) - m_{\text{count}}^{\text{ACK}}(i)) / (N_L \cdot Q_m) \right\rceil;$$

end if

$$\text{for } j = 0 \text{ to } m_{\text{count}}^{\text{RE}} - 1$$

$$k = \bar{\Phi}_l^{\text{rvd}}(j \cdot d);$$

$$\text{for } v = 0 \text{ to } N_L \cdot Q_m - 1$$

$$\bar{g}_{l,k,v} = g_{m_{\text{count,all}}^{\text{ACK}}};$$

$$m_{\text{count,all}}^{\text{ACK}} = m_{\text{count,all}}^{\text{ACK}} + 1;$$

$$m_{\text{count}}^{\text{ACK}}(i) = m_{\text{count}}^{\text{ACK}}(i) + 1;$$

end for

end for

end if

$$l = l + 1;$$

end while

end for

end if

### **Step 6:**

Set  $t = 0$ ;

$$\text{for } l = 0 \text{ to } N_{\text{symb,all}}^{\text{PUSCH}} - 1$$

$$\text{for } j = 0 \text{ to } M_{\text{sc}}^{\text{UL-SCH}}(l) - 1$$

$$k = \Phi_l^{\text{UL-SCH}}(j);$$

$$\text{for } v = 0 \text{ to } N_L \cdot Q_m - 1$$

$$g_t = \bar{g}_{l,k,v};$$

$$t = t + 1;$$

end for

end for



end for

## 6.3 Uplink control information

### 6.3.1 Uplink control information on PUCCH

The procedure in this clause applies to PUCCH formats 2/3/4.

The following clauses 6.3.1.2, 6.3.1.3 and 6.3.1.5 apply regardless of whether the higher layer parameter *uci-MuxWithDiffPrio* is configured or not. The following clauses 6.3.1.1, 6.3.1.4 and 6.3.1.6 apply by assuming *uci-MuxWithDiffPrio* is not configured, or *uci-MuxWithDiffPrio* is configured and the UCIs for transmission on a PUCCH are of the same priority index, unless stated otherwise.

If the UE is configured with a PUCCH-SCell, *uci-MuxWithDiffPrio* is replaced by *uci-MuxWithDiffPrioSecondaryPUCCHgroup* for the secondary PUCCH group in this clause.

#### 6.3.1.1 UCI bit sequence generation

##### 6.3.1.1.1 HARQ-ACK/SR only

If only HARQ-ACK bits are transmitted on a PUCCH, the UCI bit sequence  $a_0, a_1, a_2, a_3, \dots, a_{A-1}$  is determined by setting  $a_i = \tilde{o}_i^{ACK}$  for  $i = 0, 1, \dots, O^{ACK} - 1$  and  $A = O^{ACK}$ , where the HARQ-ACK bit sequence  $\tilde{o}_0^{ACK}, \tilde{o}_1^{ACK}, \dots, \tilde{o}_{O^{ACK}-1}^{ACK}$  is given by Clause 9.1 of [5, TS38.213].

If only HARQ-ACK and SR bits are transmitted on a PUCCH, the UCI bit sequence  $a_0, a_1, a_2, a_3, \dots, a_{A-1}$  is determined by setting  $a_i = \tilde{o}_i^{ACK}$  for  $i = 0, 1, \dots, O^{ACK} - 1$ ,  $a_i = \tilde{o}_{i-O^{ACK}}^{SR}$  for  $i = O^{ACK}, O^{ACK} + 1, \dots, O^{ACK} + O^{SR} - 1$ , and  $A = O^{ACK} + O^{SR}$ , where the HARQ-ACK bit sequence  $\tilde{o}_0^{ACK}, \tilde{o}_1^{ACK}, \dots, \tilde{o}_{O^{ACK}-1}^{ACK}$  is given by Clause 9.1 of [5, TS 38.213], and the SR bit sequence  $\tilde{o}_0^{SR}, \tilde{o}_1^{SR}, \dots, \tilde{o}_{O^{SR}-1}^{SR}$  is given by Clause 9.2.5.1 of [5, TS 38.213].

##### 6.3.1.1.2 CSI only

If *cqi-BitsPerSubband* is configured, this Clause 6.3.1.1.2 applies by taking Subband CQI as Subband differential CQI and replacing the corresponding number of bits 2 by 4.

The bitwidth for PMI of *codebookType=typeI-SinglePanel* with 2 CSI-RS ports is 2 for Rank=1 and 1 for Rank=2, according to Clause 5.2.2.2.1 in [6, TS 38.214].

The bitwidth for PMI of *codebookType=typeI-SinglePanel* with more than 2 CSI-RS ports is provided in Tables 6.3.1.1.2-1, where the values of  $(N_1, N_2)$  and  $(O_1, O_2)$  are given by Clause 5.2.2.2.1 in [6, TS 38.214].

**Table 6.3.1.1.2-1: PMI of *codebookType=typeI-SinglePanel***

| Information field $X_1$ for wideband PMI |                        |           | Information field $X_2$ for wideband PMI or per subband PMI |                        |
|------------------------------------------|------------------------|-----------|-------------------------------------------------------------|------------------------|
| $(i_{1,1}, i_{1,2})$                     |                        | $i_{1,3}$ | $i_2$                                                       |                        |
| <i>codebookMode</i> =1                   | <i>codebookMode</i> =2 |           | <i>codebookMode</i> =1                                      | <i>codebookMode</i> =2 |

|                                                                                                 |                                                                          |                                                                                    |     |   |   |
|-------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|------------------------------------------------------------------------------------|-----|---|---|
| Rank = 1 with >2 CSI-RS ports,<br>$N_2 > 1$                                                     | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$           | $(\lceil \log_2 \frac{N_1 O_1}{2} \rceil, \lceil \log_2 \frac{N_2 O_2}{2} \rceil)$ | N/A | 2 | 4 |
| Rank = 1 with >2 CSI-RS ports,<br>$N_2 = 1$                                                     | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$           | $(\lceil \log_2 (\frac{N_1 O_1}{2}) \rceil, 0)$                                    | N/A | 2 | 4 |
| Rank=2 with 4 CSI-RS ports,<br>$N_2 = 1$                                                        | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$           | $(\lceil \log_2 (\frac{N_1 O_1}{2}) \rceil, 0)$                                    | 1   | 1 | 3 |
| Rank=2 with >4 CSI-RS ports,<br>$N_2 > 1$                                                       | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$           | $(\lceil \log_2 \frac{N_1 O_1}{2} \rceil, \lceil \log_2 \frac{N_2 O_2}{2} \rceil)$ | 2   | 1 | 3 |
| Rank=2 with >4 CSI-RS ports,<br>$N_2 = 1$                                                       | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$           | $(\lceil \log_2 (\frac{N_1 O_1}{2}) \rceil, 0)$                                    | 2   | 1 | 3 |
| Rank=3 or 4,<br>with 4 CSI-RS ports                                                             | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$           |                                                                                    | 0   | 1 |   |
| Rank=3 or 4,<br>with 8 or 12 CSI-RS ports                                                       | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$           |                                                                                    | 2   | 1 |   |
| Rank=3 or 4,<br>with >=16 CSI-RS ports                                                          | $(\lceil \log_2 \frac{N_1 O_1}{2} \rceil, \lceil \log_2 N_2 O_2 \rceil)$ |                                                                                    | 2   | 1 |   |
| Rank=5 or 6                                                                                     | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$           |                                                                                    | N/A | 1 |   |
| Rank=7 or 8,<br>$N_1 = 4, N_2 = 1$                                                              | $(\lceil \log_2 \frac{N_1 O_1}{2} \rceil, \lceil \log_2 N_2 O_2 \rceil)$ |                                                                                    | N/A | 1 |   |
| Rank=7 or 8,<br>$N_1 > 2, N_2 = 2$                                                              | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 \frac{N_2 O_2}{2} \rceil)$ |                                                                                    | N/A | 1 |   |
| Rank=7 or 8,<br>with<br>$N_1 > 4, N_2 = 1$<br>or<br>$N_1 = 2, N_2 = 2$ or<br>$N_1 > 2, N_2 > 2$ | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$           |                                                                                    | N/A | 1 |   |

The bitwidth for PMI of *codebookType*= *typeI-MultiPanel* is provided in Tables 6.3.1.1.2-2, where the values of  $(N_g, N_1, N_2)$  and  $(O_1, O_2)$  are given by Clause 5.2.2.2.2 in [6, TS 38.214].

Table 6.3.1.1.2-2: PMI of *codebookType*= *type1-MultiPanel*

|                                                                              | Information fields $X_1$ for wideband                          |           |             |             |             | Information fields $X_2$ for wideband or per subband |           |           |           |
|------------------------------------------------------------------------------|----------------------------------------------------------------|-----------|-------------|-------------|-------------|------------------------------------------------------|-----------|-----------|-----------|
|                                                                              | $(i_{1,1}, i_{1,2})$                                           | $i_{1,3}$ | $i_{1,4,1}$ | $i_{1,4,2}$ | $i_{1,4,3}$ | $i_2$                                                | $i_{2,0}$ | $i_{2,1}$ | $i_{2,2}$ |
| Rank=1 with $N_g = 2$<br><i>codebookMode</i> =1                              | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$ | N/A       | 2           | N/A         | N/A         | 2                                                    | N/A       | N/A       | N/A       |
| Rank=1 with $N_g = 4$<br><i>codebookMode</i> =1                              | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$ | N/A       | 2           | 2           | 2           | 2                                                    | N/A       | N/A       | N/A       |
| Rank=2 with $N_g = 2$ ,<br>$N_1 N_2 = 2$<br><i>codebookMode</i> =1           | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$ | 1         | 2           | N/A         | N/A         | 1                                                    | N/A       | N/A       | N/A       |
| Rank=3 or 4 with $N_g = 2$ ,<br>$N_1 N_2 = 2$<br><i>codebookMode</i> =1      | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$ | 0         | 2           | N/A         | N/A         | 1                                                    | N/A       | N/A       | N/A       |
| Rank=2 or 3 or 4 with $N_g = 2$ ,<br>$N_1 N_2 > 2$<br><i>codebookMode</i> =1 | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$ | 2         | 2           | N/A         | N/A         | 1                                                    | N/A       | N/A       | N/A       |
| Rank=2 with $N_g = 4$ ,<br>$N_1 N_2 = 2$<br><i>codebookMode</i> =1           | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$ | 1         | 2           | 2           | 2           | 1                                                    | N/A       | N/A       | N/A       |
| Rank=3 or 4 with $N_g = 4$ ,<br>$N_1 N_2 = 2$<br><i>codebookMode</i> =1      | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$ | 0         | 2           | 2           | 2           | 1                                                    | N/A       | N/A       | N/A       |
| Rank=2 or 3 or 4 with $N_g = 4$ ,<br>$N_1 N_2 > 2$<br><i>codebookMode</i> =1 | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$ | 2         | 2           | 2           | 2           | 1                                                    | N/A       | N/A       | N/A       |
| Rank=1 with $N_g = 2$<br><i>codebookMode</i> =2                              | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$ | N/A       | 2           | 2           | N/A         | N/A                                                  | 2         | 1         | 1         |
| Rank=2 with $N_g = 2$ ,<br>$N_1 N_2 = 2$<br><i>codebookMode</i> =2           | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$ | 1         | 2           | 2           | N/A         | N/A                                                  | 1         | 1         | 1         |

|                                                                        |                                                                |   |   |   |     |     |   |   |   |
|------------------------------------------------------------------------|----------------------------------------------------------------|---|---|---|-----|-----|---|---|---|
| Rank=3 or 4 with $N_g = 2$ ,<br>$N_1 N_2 = 2$<br>$codebookMode=2$      | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$ | 0 | 2 | 2 | N/A | N/A | 1 | 1 | 1 |
| Rank=2 or 3 or 4 with $N_g = 2$ ,<br>$N_1 N_2 > 2$<br>$codebookMode=2$ | $(\lceil \log_2 N_1 O_1 \rceil, \lceil \log_2 N_2 O_2 \rceil)$ | 2 | 2 | 2 | N/A | N/A | 1 | 1 | 1 |

The bitwidth for PMI with 1 CSI-RS port is 0.

The bitwidth for RI/LI/CQI/CRI of  $codebookType=typeI-SinglePanel$  or  $reportQuantity$  set to 'cri-RI-CQI' or 1 CSI-RS port is provided in Tables 6.3.1.1.2-3.

**Table 6.3.1.1.2-3: RI, LI, CQI, and CRI of  $codebookType=typeI-SinglePanel$ , or  $reportQuantity$  set to 'cri-RI-CQI', or 1 CSI-RS port**

| Field                                                    | Bitwidth                              |                                        |                                        |                                       |                                       |
|----------------------------------------------------------|---------------------------------------|----------------------------------------|----------------------------------------|---------------------------------------|---------------------------------------|
|                                                          | 1 antenna port                        | 2 antenna ports                        | 4 antenna ports                        | >4 antenna ports                      |                                       |
|                                                          |                                       |                                        |                                        | Rank1~4                               | Rank5~8                               |
| Rank Indicator when $codebookType=typeI-SinglePanel$     | 0                                     | $\min(1, \lceil \log_2 n_{RI} \rceil)$ | $\min(2, \lceil \log_2 n_{RI} \rceil)$ | $\lceil \log_2 n_{RI} \rceil$         | $\lceil \log_2 n_{RI} \rceil$         |
| Rank Indicator when $reportQuantity$ set to 'cri-RI-CQI' | 0                                     | 1                                      | 2                                      | 3                                     | 3                                     |
| Layer Indicator                                          | 0                                     | $\lceil \log_2 v \rceil$               | $\min(2, \lceil \log_2 v \rceil)$      | $\min(2, \lceil \log_2 v \rceil)$     | $\min(2, \lceil \log_2 v \rceil)$     |
| Wide-band CQI for the first TB                           | 4                                     | 4                                      | 4                                      | 4                                     | 4                                     |
| Wideband CQI for the second TB                           | 0                                     | 0                                      | 0                                      | 0                                     | 4                                     |
| Subband differential CQI for the first TB                | 2                                     | 2                                      | 2                                      | 2                                     | 2                                     |
| Subband differential CQI for the second TB               | 0                                     | 0                                      | 0                                      | 0                                     | 2                                     |
| CRI                                                      | $\lceil \log_2 (K_s^{CSI-RS}) \rceil$ | $\lceil \log_2 (K_s^{CSI-RS}) \rceil$  | $\lceil \log_2 (K_s^{CSI-RS}) \rceil$  | $\lceil \log_2 (K_s^{CSI-RS}) \rceil$ | $\lceil \log_2 (K_s^{CSI-RS}) \rceil$ |

$n_{RI}$  in Table 6.3.1.1.2-3 is the number of allowed rank indicator values according to Clause 5.2.2.2.1 [6, TS 38.214].

$v$  is the value of the rank. The value of  $K_s^{CSI-RS}$  is the number of CSI-RS resources in the corresponding resource set.

The values of the rank indicator field are mapped to allowed rank indicator values with increasing order, where '0' is mapped to the smallest allowed rank indicator value. For higher layer parameter  $reportQuantity$  set to 'cri-RI-CQI', the values of the rank indicator field are mapped to rank indicator values with increasing order, where '0' is mapped to rank-1.

**Table 6.3.1.1.2-3A: RI, LI, CQI, and CRI associated with one CSI-RS resource pair and *csi-ReportMode= Mode 1 or Mode 2***

| Field                                     | Bitwidth                              |                                                    |
|-------------------------------------------|---------------------------------------|----------------------------------------------------|
|                                           | 1 antenna port per Resource           | >1 antenna ports per Resource                      |
| Rank Combination Indicator                | 0                                     | $\min(2, \lceil \log_2 n_{\text{RI,NCJT}} \rceil)$ |
| The first Layer Indicator                 | 0                                     | $\lceil \log_2(v_1) \rceil$                        |
| The second Layer Indicator                | 0                                     | $\lceil \log_2(v_2) \rceil$                        |
| Wide-band CQI for the first TB            | 4                                     | 4                                                  |
| Subband differential CQI for the first TB | 2                                     | 2                                                  |
| CRI if <i>csi-ReportMode= Mode 1</i>      | $\lceil \log_2 N \rceil$              | $\lceil \log_2 N \rceil$                           |
| CRI if <i>csi-ReportMode= Mode 2</i>      | $\lceil \log_2(M_1 + M_2 + N) \rceil$ | $\lceil \log_2(M_1 + M_2 + N) \rceil$              |

**Table 6.3.1.1.2-3B: RI, LI, CQI, and CRI associated with one CSI-RS resource and *csi-ReportMode= Mode 1 or Mode 2***

| Field                                                                           | Bitwidth                                                                                         |                                                                                                  |                                                                                                  |                                                                                                  |                                                                                                  |
|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
|                                                                                 | 1 antenna port                                                                                   | 2 antenna ports                                                                                  | 4 antenna ports                                                                                  | >4 antenna ports                                                                                 |                                                                                                  |
|                                                                                 |                                                                                                  |                                                                                                  |                                                                                                  | Rank1~4                                                                                          | Rank5~8                                                                                          |
| Rank Indicator                                                                  | 0                                                                                                | $\min(1, \lceil \log_2 n_{\text{RI,STR}} \rceil)$                                                | $\min(2, \lceil \log_2 n_{\text{RI,STR}} \rceil)$                                                | $\lceil \log_2 n_{\text{RI,STRP}} \rceil$                                                        | $\lceil \log_2 n_{\text{RI,STRP}} \rceil$                                                        |
| Layer Indicator                                                                 | 0                                                                                                | $\lceil \log_2(v) \rceil$                                                                        | $\min(2, \lceil \log_2(v) \rceil)$                                                               | $\min(2, \lceil \log_2(v) \rceil)$                                                               | $\min(2, \lceil \log_2(v) \rceil)$                                                               |
| Wide-band CQI for the first TB                                                  | 4                                                                                                | 4                                                                                                | 4                                                                                                | 4                                                                                                | 4                                                                                                |
| Wideband CQI for the second TB                                                  | 0                                                                                                | 0                                                                                                | 0                                                                                                | 0                                                                                                | 4                                                                                                |
| Subband differential CQI for the first TB                                       | 2                                                                                                | 2                                                                                                | 2                                                                                                | 2                                                                                                | 2                                                                                                |
| Subband differential CQI for the second TB                                      | 0                                                                                                | 0                                                                                                | 0                                                                                                | 0                                                                                                | 2                                                                                                |
| CRI if <i>csi-ReportMode= Mode 1</i> and <i>numberOfSingleTRP-CSI-Mode1 = 1</i> | $\lceil \log_2(M_1 + M_2) \rceil$                                                                | $\lceil \log_2(M_1 + M_2) \rceil$                                                                | $\lceil \log_2(M_1 + M_2) \rceil$                                                                | $\lceil \log_2(M_1 + M_2) \rceil$                                                                | $\lceil \log_2(M_1 + M_2) \rceil$                                                                |
| CRI if <i>csi-ReportMode= Mode 1</i> and <i>numberOfSingleTRP-CSI-Mode1 = 2</i> | $\lceil \log_2(M_1) \rceil$ for the first CRI;<br>$\lceil \log_2(M_2) \rceil$ for the second CRI | $\lceil \log_2(M_1) \rceil$ for the first CRI;<br>$\lceil \log_2(M_2) \rceil$ for the second CRI | $\lceil \log_2(M_1) \rceil$ for the first CRI;<br>$\lceil \log_2(M_2) \rceil$ for the second CRI | $\lceil \log_2(M_1) \rceil$ for the first CRI;<br>$\lceil \log_2(M_2) \rceil$ for the second CRI | $\lceil \log_2(M_1) \rceil$ for the first CRI;<br>$\lceil \log_2(M_2) \rceil$ for the second CRI |
| CRI if <i>csi-ReportMode= Mode 2</i>                                            | $\lceil \log_2(M_1 + M_2 + N) \rceil$                                                            | $\lceil \log_2(M_1 + M_2 + N) \rceil$                                                            | $\lceil \log_2(M_1 + M_2 + N) \rceil$                                                            | $\lceil \log_2(M_1 + M_2 + N) \rceil$                                                            | $\lceil \log_2(M_1 + M_2 + N) \rceil$                                                            |

$n_{\text{RI,NCJT}}$  in Table 6.3.1.1.2-3A is the number of allowed rank combination indicator values associated with one CSI-RS resource pair according to Clause 5.2.1.4.2 [6, TS 38.214]. The values of the rank combination indicator field are mapped to allowed rank combinations in the following order: {1,1}, {1,2}, {2,1}, {2,2}, where '0' is mapped to the first allowed rank combination.  $v_1$  and  $v_2$  are the values of the first and the second rank associated with two CSI-RS resources of the CSI-RS resource pair respectively.

$n_{\text{RI,STRP}}$  in Table 6.3.1.1.2-3B is the number of allowed rank indicator values associated with one CSI-RS resource according to Clause 5.2.1.4.2 [6, TS 38.214].  $v$  is the value of the rank associated with the CSI-RS resource. The values of the rank indicator field are mapped to allowed rank indicator values with increasing order, where '0' is mapped to the smallest allowed rank indicator value.

The value of  $N$  in Table 6.3.1.1.2-3A and Table 6.3.1.1.2-3B is the number of CSI-RS resource pairs configured within a CSI-RS resource set. The values of  $M_1$  and  $M_2$  in Table 6.3.1.1.2-3A and Table 6.3.1.1.2-3B are given by

- If *sharedCMR* = "Enabled",  $M_1 = K_1$  and  $M_2 = K_2$

- If *sharedCMR* is absent and  $N = 1$ ,  $M_1 = K_1 - 1$  and  $M_2 = K_2 - 1$
- If *sharedCMR* is absent and  $N = 2$ ,
  - $M_1 = K_1 - 2$  and  $M_2 = K_2 - 2$ , if the two resource pairs do not share any CSI-RS resource
  - $M_1 = K_1 - 1$  and  $M_2 = K_2 - 2$ , if the two resource pairs share the same CSI-RS resource from the first CSI-RS resource group
  - $M_1 = K_1 - 2$  and  $M_2 = K_2 - 1$ , if the two resource pairs share the same CSI-RS resource from the second CSI-RS resource group

where the values of  $K_1$  and  $K_2$  are the numbers of CSI-RS resources in the first and second CSI-RS resource groups within the CSI-RS resource set respectively.

The bitwidth for RI/LI/CQI/CRI of *codebookType*= *typeI-MultiPanel* is provided in Table 6.3.1.1.2-4.

**Table 6.3.1.1.2-4: RI, LI, CQI, and CRI of *codebookType*=*typeI-MultiPanel***

| Field                    | Bitwidth                                      |
|--------------------------|-----------------------------------------------|
| Rank Indicator           | $\min(2, \lceil \log_2 n_{\text{RI}} \rceil)$ |
| Layer Indicator          | $\min(2, \lceil \log_2 \nu \rceil)$           |
| Wide-band CQI            | 4                                             |
| Subband differential CQI | 2                                             |
| CRI                      | $\lceil \log_2 (K_s^{\text{CSI-RS}}) \rceil$  |

where  $n_{\text{RI}}$  is the number of allowed rank indicator values according to Clause 5.2.2.2.2 [6, TS 38.214],  $\nu$  is the value of the rank, and  $K_s^{\text{CSI-RS}}$  is the number of CSI-RS resources in the corresponding resource set. The values of the rank indicator field are mapped to allowed rank indicator values with increasing order, where '0' is mapped to the smallest allowed rank indicator value.

The bitwidth for RI/LI/CQI of *codebookType*= *typeII* or *codebookType*=*typeII-PortSelection* is provided in Table 6.3.1.1.2-5.

**Table 6.3.1.1.2-5: RI, LI, and CQI of *codebookType*=*typeII* or *typeII-PortSelection***

| Field                                                                                   | Bitwidth                                      |
|-----------------------------------------------------------------------------------------|-----------------------------------------------|
| Rank Indicator                                                                          | $\min(1, \lceil \log_2 n_{\text{RI}} \rceil)$ |
| Layer Indicator                                                                         | $\min(2, \lceil \log_2 \nu \rceil)$           |
| Wide-band CQI                                                                           | 4                                             |
| Subband differential CQI                                                                | 2                                             |
| Indicator of the number of non-zero wideband amplitude coefficients $M_l$ for layer $l$ | $\lceil \log_2 (2L - 1) \rceil$               |

where  $n_{\text{RI}}$  is the number of allowed rank indicator values according to Clauses 5.2.2.2.3 and 5.2.2.2.4 [6, TS 38.214] and  $\nu$  is the value of the rank. The values of the rank indicator field are mapped to allowed rank indicator values with increasing order, where '0' is mapped to the smallest allowed rank indicator value.

The bitwidth for CRI, SSBRI, RSRP, differential RSRP, and CapabilityIndex are provided in Table 6.3.1.1.2-6.

**Table 6.3.1.1.2-6: CRI, SSBRI, RSRP, and CapabilityIndex**

| Field             | Bitwidth                                    |
|-------------------|---------------------------------------------|
| CRI               | $\lceil \log_2(K_s^{\text{CSI-RS}}) \rceil$ |
| SSBRI             | $\lceil \log_2(K_s^{\text{SSB}}) \rceil$    |
| RSRP              | 7                                           |
| Differential RSRP | 4                                           |
| CapabilityIndex   | 2                                           |

where  $K_s^{\text{CSI-RS}}$  is the number of CSI-RS resources in the corresponding resource set, and  $K_s^{\text{SSB}}$  is the configured number of SS/PBCH blocks in the corresponding resource set for reporting 'ssb-Index-RSRP' or 'ssb-Index-RSRP-Index'.

The bitwidth for CRI, SSBRI, SINR, differential SINR, and CapabilityIndex are provided in Table 6.3.1.1.2-6A.

**Table 6.3.1.1.2-6A: CRI, SSBRI, SINR, and CapabilityIndex**

| Field             | Bitwidth                                    |
|-------------------|---------------------------------------------|
| CRI               | $\lceil \log_2(K_s^{\text{CSI-RS}}) \rceil$ |
| SSBRI             | $\lceil \log_2(K_s^{\text{SSB}}) \rceil$    |
| SINR              | 7                                           |
| Differential SINR | 4                                           |
| CapabilityIndex   | 2                                           |

where  $K_s^{\text{CSI-RS}}$  is the number of CSI-RS resources in the corresponding resource set, and  $K_s^{\text{SSB}}$  is the configured number of SS/PBCH blocks in the corresponding resource set for reporting 'ssb-Index-SINR' or 'ssb-Index-SINR-Index'.

**Table 6.3.1.1.2-7: Mapping order of CSI fields of one CSI report, *pmi-FormatIndicator=widebandPMI* and *cqi-FormatIndicator=widebandCQI* or *reportQuantity* set to 'cri-RI-CQI' and *cqi-FormatIndicator=widebandCQI***

| CSI report number | CSI fields                                                                                                                                                                               |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report #n     | CRI as in Tables 6.3.1.1.2-3/4, if reported                                                                                                                                              |
|                   | Rank Indicator as in Tables 6.3.1.1.2-3/4, if reported                                                                                                                                   |
|                   | Layer Indicator as in Tables 6.3.1.1.2-3/4, if reported                                                                                                                                  |
|                   | Zero padding bits $O_p$ , if needed                                                                                                                                                      |
|                   | PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1/2, if reported                                                                                       |
|                   | PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1/2, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214], if reported |
|                   | Wideband CQI for the first TB as in Tables 6.3.1.1.2-3/4, if reported                                                                                                                    |
|                   | Wideband CQI for the second TB as in Tables 6.3.1.1.2-3/4, if reported                                                                                                                   |

The number of zero padding bits  $O_p$  in Table 6.3.1.1.2-7 is 0 for 1 CSI-RS port and  $O_p = N_{\text{max}} - N_{\text{reported}}$  for more than 1 CSI-RS port, where

- $N_{\text{max}} = \max_{r \in S_{\text{Rank}}} B(r)$  and  $S_{\text{Rank}}$  is the set of rank values  $r$  that are allowed to be reported;
- $N_{\text{reported}} = B(R)$ , where  $R$  is the reported rank;
- For 2 CSI-RS ports,  $B(r) = N_{\text{PMI}}(r) + N_{\text{CQI}}(r) + N_{\text{LI}}(r)$ ;

- For more than 2 CSI-RS ports,  $B(r) = N_{PMI,i1}(r) + N_{PMI,i2}(r) + N_{CQI}(r) + N_{LI}(r)$ ;
- if PMI is reported,  $N_{PMI}(1) = 2$  and  $N_{PMI}(2) = 1$ ; otherwise,  $N_{PMI}(r) = 0$ ;
- if PMI  $i_1$  is reported,  $N_{PMI,i1}(r)$  is obtained according to Tables 6.3.1.1.2-1/2; otherwise,  $N_{PMI,i1}(r) = 0$ ;
- if PMI  $i_2$  is reported,  $N_{PMI,i2}(r)$  is obtained according to Tables 6.3.1.1.2-1/2; otherwise,  $N_{PMI,i2}(r) = 0$ ;
- if CQI is reported,  $N_{CQI}(r)$  is obtained according to Tables 6.3.1.1.2-3/4; otherwise,  $N_{CQI}(r) = 0$ ;
- if LI is reported,  $N_{LI}(r)$  is obtained according to Tables 6.3.1.1.2-3/4; otherwise,  $N_{LI}(r) = 0$ .

**Table 6.3.1.1.2-7A: Mapping order of CSI fields of one CSI report, *pmi-FormatIndicator=widebandPMI*, *cqi-FormatIndicator=widebandCQI*, *csi-ReportMode= Mode 1* and *numberOfSingleTRP-CSI-Mode1=0***

| CSI report number | CSI fields                                                                                                                                                                                                                                                        |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report #n     | CRI as in Tables 6.3.1.1.2-3A, if reported                                                                                                                                                                                                                        |
|                   | Rank Combination Indicator as in Tables 6.3.1.1.2-3A, if reported                                                                                                                                                                                                 |
|                   | Two Layer Indicators as in Table 6.3.1.1.2-3A, where the first Layer Indicator and the second Layer Indicator are associated with the first resource and the second resource within the resource pair respectively and if reported;                               |
|                   | Zero padding bits $O_P$ , if needed                                                                                                                                                                                                                               |
|                   | PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1 associated with the first resource within the CSI-RS resource pair, if reported                                                                                               |
|                   | PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214] associated with the first CSI-RS resource within the CSI-RS resource pair, if reported  |
|                   | PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1 associated with the second resource within the CSI-RS resource pair, if reported                                                                                              |
|                   | PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214] associated with the second CSI-RS resource within the CSI-RS resource pair, if reported |
|                   | Wideband CQI for the first TB as in Tables 6.3.1.1.2-3A, if reported                                                                                                                                                                                              |

The number of zero padding bits  $O_P$  in Table 6.3.1.1.2-7A is 0 for 1 CSI-RS port and  $O_P = N_{\max} - N_{\text{reported}}$  for more than 1 CSI-RS port, where

- $N_{\max} = \max_{r \in S_{Rank}} B(r)$  and  $S_{Rank}$  is the set of rank combination values of  $r = \{r_1, r_2\}$  that are allowed to be reported;
- $N_{\text{reported}} = B(R)$  where  $R$  is the reported rank combination;
- For 2 CSI-RS ports,  $B(r) = N_{PMI}(r_1) + N_{PMI}(r_2) + N_{CQI}(r) + N_{LI}(r_1) + N_{LI}(r_2)$ ;
- For more than 2 CSI-RS ports,  $B(r) = N_{PMI,i1}(r_1) + N_{PMI,i1}(r_2) + N_{PMI,i2}(r_1) + N_{PMI,i2}(r_2) + N_{CQI}(r) + N_{LI}(r_1) + N_{LI}(r_2)$ ;
- if PMI is reported,  $N_{PMI}(1) = 2$  and  $N_{PMI}(2) = 1$ ; otherwise,  $N_{PMI} = 0$ ;
- if PMI  $i_1$  is reported,  $N_{PMI,i1}(r_1)$  and  $N_{PMI,i1}(r_2)$  are obtained according to Tables 6.3.1.1.2-1; otherwise,  $N_{PMI,i1} = 0$ ;
- if PMI  $i_2$  is reported,  $N_{PMI,i2}(r_1)$  and  $N_{PMI,i2}(r_2)$  are obtained according to Tables 6.3.1.1.2-1; otherwise,  $N_{PMI,i2} = 0$ ;
- if CQI is reported,  $N_{CQI}(r)$  is obtained according to Tables 6.3.1.1.2-3A; otherwise,  $N_{CQI}(r) = 0$ ;
- if LI is reported,  $N_{LI}(r_1)$  and  $N_{LI}(r_2)$  are obtained according to Tables 6.3.1.1.2-3A; otherwise,  $N_{LI} = 0$ .



**Table 6.3.1.1.2-8: Mapping order of CSI fields of one report for CRI/RSRP or SSBRI/RSRP or CRI/RSRP/CapabilityIndex or SSBRI/RSRP/CapabilityIndex reporting, or mapping order of CSI fields of one report for inter-cell SSBRI/RSRP reporting**

| CSI report number | CSI fields                                                |
|-------------------|-----------------------------------------------------------|
| CSI report #n     | CRI or SSBRI #1 as in Table 6.3.1.1.2-6, if reported      |
|                   | CRI or SSBRI #2 as in Table 6.3.1.1.2-6, if reported      |
|                   | CRI or SSBRI #3 as in Table 6.3.1.1.2-6, if reported      |
|                   | CRI or SSBRI #4 as in Table 6.3.1.1.2-6, if reported      |
|                   | RSRP #1 as in Table 6.3.1.1.2-6, if reported              |
|                   | Differential RSRP #2 as in Table 6.3.1.1.2-6, if reported |
|                   | Differential RSRP #3 as in Table 6.3.1.1.2-6, if reported |
|                   | Differential RSRP #4 as in Table 6.3.1.1.2-6, if reported |
|                   | CapabilityIndex #1 as in Table 6.3.1.1.2-6, if reported   |
|                   | CapabilityIndex #2 as in Table 6.3.1.1.2-6, if reported   |
|                   | CapabilityIndex #3 as in Table 6.3.1.1.2-6, if reported   |
|                   | CapabilityIndex #4 as in Table 6.3.1.1.2-6, if reported   |

**Table 6.3.1.1.2-8A: Mapping order of CSI fields of one report for CRI/SINR or SSBRI/SINR or CRI/SINR/CapabilityIndex or SSBRI/SINR/CapabilityIndex reporting**

| CSI report number | CSI fields                                                 |
|-------------------|------------------------------------------------------------|
| CSI report #n     | CRI or SSBRI #1 as in Table 6.3.1.1.2-6A, if reported      |
|                   | CRI or SSBRI #2 as in Table 6.3.1.1.2-6A, if reported      |
|                   | CRI or SSBRI #3 as in Table 6.3.1.1.2-6A, if reported      |
|                   | CRI or SSBRI #4 as in Table 6.3.1.1.2-6A, if reported      |
|                   | SINR #1 as in Table 6.3.1.1.2-6A, if reported              |
|                   | Differential SINR #2 as in Table 6.3.1.1.2-6A, if reported |
|                   | Differential SINR #3 as in Table 6.3.1.1.2-6A, if reported |
|                   | Differential SINR #4 as in Table 6.3.1.1.2-6A, if reported |
|                   | CapabilityIndex #1 as in Table 6.3.1.1.2-6, if reported    |
|                   | CapabilityIndex #2 as in Table 6.3.1.1.2-6, if reported    |
|                   | CapabilityIndex #3 as in Table 6.3.1.1.2-6, if reported    |
|                   | CapabilityIndex #4 as in Table 6.3.1.1.2-6, if reported    |

**Table 6.3.1.1.2-8B: Mapping order of CSI fields of one report for group-based CRI/RSRP or SSBRI/RSRP reporting**

| CSI report number | CSI fields                                                                                      |
|-------------------|-------------------------------------------------------------------------------------------------|
| CSI report #n     | Resource set indicator                                                                          |
|                   | CRI or SSBRI #1 of 1st resource group as in Table 6.3.1.1.2-6, if reported                      |
|                   | CRI or SSBRI #2 of 1st resource group as in Table 6.3.1.1.2-6, if reported                      |
|                   | CRI or SSBRI #1 of 2nd resource group as in Table 6.3.1.1.2-6, if reported                      |
|                   | CRI or SSBRI #2 of 2nd resource group as in Table 6.3.1.1.2-6, if reported                      |
|                   | CRI or SSBRI #1 of 3rd resource group as in Table 6.3.1.1.2-6, if reported                      |
|                   | CRI or SSBRI #2 of 3rd resource group as in Table 6.3.1.1.2-6, if reported                      |
|                   | CRI or SSBRI #1 of 4th resource group as in Table 6.3.1.1.2-6, if reported                      |
|                   | CRI or SSBRI #2 of 4th resource group as in Table 6.3.1.1.2-6, if reported                      |
|                   | RSRP of CRI or SSBRI #1 of 1st resource group as in Table 6.3.1.1.2-6                           |
|                   | Differential RSRP of CRI or SSBRI #2 of 1st resource group as in Table 6.3.1.1.2-6              |
|                   | Differential RSRP of CRI or SSBRI #1 of 2nd resource group as in Table 6.3.1.1.2-6, if reported |
|                   | Differential RSRP of CRI or SSBRI #2 of 2nd resource group as in Table 6.3.1.1.2-6, if reported |
|                   | Differential RSRP of CRI or SSBRI #1 of 3rd resource group as in Table 6.3.1.1.2-6, if reported |
|                   | Differential RSRP of CRI or SSBRI #2 of 3rd resource group as in Table 6.3.1.1.2-6, if reported |
|                   | Differential RSRP of CRI or SSBRI #1 of 4th resource group as in Table 6.3.1.1.2-6, if reported |
|                   | Differential RSRP of CRI or SSBRI #2 of 4th resource group as in Table 6.3.1.1.2-6, if reported |

where the 1-bit resource set indicator, with value of 0 or 1, indicates the 1<sup>st</sup> or the 2<sup>nd</sup> channel measurement resource set respectively, from which CRI or SSBRI #1 of 1<sup>st</sup> resource group is reported from; and all remaining resource groups, if reported, follow the same mapping order as the 1<sup>st</sup> resource group where CRI or SSBRI #1 of all remaining resource groups is reported from the indicated channel measurement resource set. For all reported resource groups, CRI or SSBRI #1 and CRI or SSBRI #2 are reported from different channel measurement resource sets.

**Table 6.3.1.1.2-9: Mapping order of CSI fields of one CSI report, CSI part 1, *pmi-FormatIndicator*=*subbandPMI* or *cqi-FormatIndicator*=*subbandCQI***

| CSI report number           | CSI fields                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report #n<br>CSI part 1 | CRI as in Tables 6.3.1.1.2-3/4, if reported                                                                                                                                                                                                                                                                                                       |
|                             | Rank Indicator as in Tables 6.3.1.1.2-3/4/5, if reported                                                                                                                                                                                                                                                                                          |
|                             | Wideband CQI for the first TB as in Tables 6.3.1.1.2-3/4/5, if reported                                                                                                                                                                                                                                                                           |
|                             | Subband differential CQI for the first TB with increasing order of subband number as in Tables 6.3.1.1.2-3/4/5, if reported                                                                                                                                                                                                                       |
|                             | Indicator of the number of non-zero wideband amplitude coefficients $M_0$ for layer 0 as in Table 6.3.1.1.2-5, if reported                                                                                                                                                                                                                        |
|                             | Indicator of the number of non-zero wideband amplitude coefficients $M_1$ for layer 1 as in Table 6.3.1.1.2-5 (if the rank according to the reported RI is equal to one, this field is set to all zeros), if 2-layer PMI reporting is allowed according to the rank restriction in Clauses 5.2.2.2.3 and 5.2.2.2.4 [6, TS 38.214] and if reported |
| Note:                       | Subbands for given CSI report $n$ indicated by the higher layer parameter <i>csi-ReportingBand</i> with value set to '1' are numbered continuously in the increasing order with the lowest subband of <i>csi-ReportingBand</i> with value set to '1' as subband 0.                                                                                |

**Table 6.3.1.1.2-9A: Mapping order of CSI fields of one CSI report, CSI part 1, *csi-ReportMode*= *Mode 1***

| CSI report number                   | CSI fields                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report # <i>n</i><br>CSI part 1 | CRI as in Tables 6.3.1.1.2-3A, if associated with one CSI-RS resource pair and if reported                                                                                                                                                                                                                                                                                                      |
|                                     | Rank Combination Indicator as in Tables 6.3.1.1.2-3A, if reported                                                                                                                                                                                                                                                                                                                               |
|                                     | Wideband CQI for the first TB as in Tables 6.3.1.1.2-3A, if reported                                                                                                                                                                                                                                                                                                                            |
|                                     | Subband differential CQI for the first TB with increasing order of subband number as in Tables 6.3.1.1.2-3A, if reported                                                                                                                                                                                                                                                                        |
|                                     | CRI as in Tables 6.3.1.1.2-3B, if associated with one CSI-RS resource, <i>numberOfSingleTRP-CSI-Mode1</i> = 1 and if reported;<br>First CRI as in Tables 6.3.1.1.2-3B, if associated with one CSI-RS resource, <i>numberOfSingleTRP-CSI-Mode1</i> = 2 and if reported                                                                                                                           |
|                                     | Rank Indicator associated with CRI as in Tables 6.3.1.1.2-3B, if <i>numberOfSingleTRP-CSI-Mode1</i> = 1 and if reported;<br>Rank Indicator associated with the first CRI as in Tables 6.3.1.1.2-3B, if <i>numberOfSingleTRP-CSI-Mode1</i> = 2 and if reported                                                                                                                                   |
|                                     | Wideband CQI associated with CRI for the first TB as in Tables 6.3.1.1.2-3B, if <i>numberOfSingleTRP-CSI-Mode1</i> = 1 and if reported;<br>Wideband CQI associated with the first CRI for the first TB as in Tables 6.3.1.1.2-3B, if <i>numberOfSingleTRP-CSI-Mode1</i> = 2 and if reported                                                                                                     |
|                                     | Subband differential CQI associated with CRI for the first TB with increasing order of subband number as in Tables 6.3.1.1.2-3B, if <i>numberOfSingleTRP-CSI-Mode1</i> = 1 if reported;<br>Subband differential CQI associated with the first CRI for the first TB with increasing order of subband number as in Tables 6.3.1.1.2-3B, if <i>numberOfSingleTRP-CSI-Mode1</i> = 2 and if reported |
|                                     | Second CRI as in Tables 6.3.1.1.2-3B, if associated with one CSI-RS resource, <i>numberOfSingleTRP-CSI-Mode1</i> = 2 and if reported                                                                                                                                                                                                                                                            |
|                                     | Rank Indicator associated with the second CRI as in Tables 6.3.1.1.2-3B, if <i>numberOfSingleTRP-CSI-Mode1</i> = 2 and if reported                                                                                                                                                                                                                                                              |
|                                     | Wideband CQI associated with the second CRI for the first TB as in Tables 6.3.1.1.2-3B, if <i>numberOfSingleTRP-CSI-Mode1</i> = 2 and if reported                                                                                                                                                                                                                                               |
|                                     | Subband differential CQI associated with the second CRI for the first TB with increasing order of subband number as in Tables 6.3.1.1.2-3B, if <i>numberOfSingleTRP-CSI-Mode1</i> = 2 and if reported                                                                                                                                                                                           |
| Note:                               | Subbands for given CSI report <i>n</i> indicated by the higher layer parameter <i>csi-ReportingBand</i> with value set to '1' are numbered continuously in the increasing order with the lowest subband of <i>csi-ReportingBand</i> with value set to '1' as subband 0.                                                                                                                         |

**Table 6.3.1.1.2-9B: Mapping order of CSI fields of one CSI report, CSI part 1, *csi-ReportMode*= *Mode 2***

| CSI report number                   | CSI fields                                                                                                                                                                                                                                                                                                                                       |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report # <i>n</i><br>CSI part 1 | CRI as in Tables 6.3.1.1.2-3A, if associated with one CSI-RS resource pair and if reported;<br>CRI as in Tables 6.3.1.1.2-3B, if associated with one CSI-RS resource and if reported                                                                                                                                                             |
|                                     | Rank Combination Indicator as in Tables 6.3.1.1.2-3A, if associated with one CSI-RS resource pair and if reported;<br>Rank Indicator as in Tables 6.3.1.1.2-3B, if associated with one CSI-RS resource and if reported;<br>Zero padding bits $O_p$ , if needed                                                                                   |
|                                     | Wideband CQI for the first TB as in Tables 6.3.1.1.2-3A, if associated with one CSI-RS resource pair and if reported;<br>Wideband CQI for the first TB as in Tables 6.3.1.1.2-3B, if associated with one CSI-RS resource and if reported                                                                                                         |
|                                     | Subband differential CQI for the first TB with increasing order of subband number as in Tables 6.3.1.1.2-3A, if associated with one CSI-RS resource pair and if reported;<br>Subband differential CQI for the first TB with increasing order of subband number as in Tables 6.3.1.1.2-3B, if associated with one CSI-RS resource and if reported |
| Note:                               | Subbands for given CSI report <i>n</i> indicated by the higher layer parameter <i>csi-ReportingBand</i> with value set to '1' are numbered continuously in the increasing order with the lowest subband of <i>csi-ReportingBand</i> with value set to '1' as subband 0.                                                                          |

The number of zero padding bits  $O_p$  in Table 6.3.1.1.2-9B is 0 for 1 CSI-RS port and  $O_p = N_{\max} - N_{\text{reported}}(R)$  for more than 1 CSI-RS port, where

- $N_{\max} = \max_{r \in S_{\text{Rank}}} N(r)$ .  $S_{\text{Rank}}$  is the set of rank and rank combination values  $r$  that are allowed to be reported.  $N(r)$  is obtained according to Tables 6.3.1.1.2-3A/3B for rank combination indicator and rank indicator respectively.
- $N_{\text{reported}}(R)$  is obtained according to Tables 6.3.1.1.2-3A for rank combination indicator and  $R$  is the reported rank combination.
- $N_{\text{reported}}(R)$  is obtained according to Tables 6.3.1.1.2-3B for rank indicator and  $R$  is the reported rank.

**Table 6.3.1.1.2-10: Mapping order of CSI fields of one CSI report, CSI part 2 wideband, *pmi-FormatIndicator*= *subbandPMI* or *cqi-FormatIndicator*=*subbandCQI***

| CSI report number                       | CSI fields                                                                                                                                                                                                                                      |
|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report #n<br>CSI part 2<br>wideband | Wideband CQI for the second TB as in Tables 6.3.1.1.2-3/4/5, if present and reported                                                                                                                                                            |
|                                         | Layer Indicator as in Tables 6.3.1.1.2-3/4/5, if reported                                                                                                                                                                                       |
|                                         | PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1/2, if reported                                                                                                                                              |
|                                         | PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1/2, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214], if <i>pmi-FormatIndicator</i> = <i>widebandPMI</i> and if reported |

**Table 6.3.1.1.2-10A: Mapping order of CSI fields of one CSI report, CSI part 2 wideband, *csi-ReportMode= Mode 1***

| CSI report number                       | CSI fields                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report #n<br>CSI part 2<br>wideband | Two Layer Indicators as in Table 6.3.1.1.2-3A, where the first Layer Indicator and the second Layer Indicator are associated with the first resource and the second resource within the resource pair respectively and if reported;                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                         | PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1 associated with the first resource within the CSI-RS resource pair, if reported                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                         | PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214] associated with the first CSI-RS resource within the CSI-RS resource pair, if <i>pmi-FormatIndicator= widebandPMI</i> and if reported                                                                                                                                                                                                                                                                                                                                   |
|                                         | PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1 associated with the second resource within the CSI-RS resource pair, if reported                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                                         | PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214] associated with the second CSI-RS resource within the CSI-RS resource pair, if <i>pmi-FormatIndicator= widebandPMI</i> and if reported                                                                                                                                                                                                                                                                                                                                  |
|                                         | Wideband CQI for the second TB as in Tables 6.3.1.1.2-3B, if associated with CRI in CSI part 1, <i>numberOfSingleTRP-CSI-Mode1 = 1</i> and if reported;<br>Wideband CQI for the second TB as in Tables 6.3.1.1.2-3B, if associated with the first CRI in CSI part 1, <i>numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                       |
|                                         | Layer Indicator as in Table 6.3.1.1.2-3B, if associated with CRI in CSI part 1, <i>numberOfSingleTRP-CSI-Mode1 = 1</i> and if reported;<br>Layer Indicator as in Table 6.3.1.1.2-3B, if associated with the first CRI in CSI part 1, <i>numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                                                       |
|                                         | PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1, if associated with CRI in CSI part 1, <i>numberOfSingleTRP-CSI-Mode1 = 1</i> and if reported;<br>PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1, if associated with the first CRI in CSI part 1, <i>numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                 |
|                                         | PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214], if associated with CRI in CSI part 1, <i>pmi-FormatIndicator= widebandPMI</i> , <i>numberOfSingleTRP-CSI-Mode1 = 1</i> and if reported;<br>PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214], if associated with the first CRI in CSI part 1, <i>pmi-FormatIndicator= widebandPMI</i> , <i>numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported |
|                                         | Wideband CQI for the second TB as in Tables 6.3.1.1.2-3B, if associated with the second CRI in CSI part 1, <i>numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|                                         | Layer Indicator as in Table 6.3.1.1.2-3B, if associated with the second CRI in CSI part 1, <i>numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|                                         | PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1, if associated with the second CRI in CSI part 1, <i>numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                                         | PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214], if associated with the second CRI in CSI part 1, <i>pmi-FormatIndicator= widebandPMI</i> , <i>numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                      |

**Table 6.3.1.1.2-10B: Mapping order of CSI fields of one CSI report, CSI part 2 wideband, *csi-ReportMode= Mode 2***

| CSI report number                       | CSI fields                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report #n<br>CSI part 2<br>wideband | Wideband CQI for the second TB as in Tables 6.3.1.1.2-3B, if reported part 1 is associated with one CSI-RS resource and if reported                                                                                                                                                                                                                                                                                        |
|                                         | Two Layer Indicators as in Table 6.3.1.1.2-3A, if reported part 1 is associated with one CSI-RS resource pair, where the first Layer Indicator and the second Layer Indicator are associated with the first resource and the second resource within the resource pair respectively and if reported;<br>Layer Indicator as in Table 6.3.1.1.2-3B, if reported part 1 is associated with one CSI-RS resource and if reported |
|                                         | PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1 associated with the first resource within the CSI-RS resource pair, if reported part 1 is associated with one CSI-RS resource pair and if reported                                                                                                                                                                                     |
|                                         | PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214] associated with the first CSI-RS resource within the CSI-RS resource pair, if <i>pmi-FormatIndicator= widebandPMI</i> and reported part 1 is associated with one CSI-RS resource pair and if reported                                            |
|                                         | PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1 associated with the second CSI-RS resource within the CSI-RS resource pair, if reported part 1 is associated with one CSI-RS resource pair and if reported                                                                                                                                                                             |
|                                         | PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214] associated with the second CSI-RS resource within the CSI-RS resource pair, if <i>pmi-FormatIndicator= widebandPMI</i> and reported part 1 is associated with one CSI-RS resource pair and if reported                                           |
|                                         | PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1, if reported part 1 is associated with one CSI-RS resource and if reported                                                                                                                                                                                                                                                             |
|                                         | PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214], if <i>pmi-FormatIndicator= widebandPMI</i> and reported part 1 is associated with one CSI-RS resource and if reported                                                                                                                           |

**Table 6.3.1.1.2-11: Mapping order of CSI fields of one CSI report, CSI part 2 subband, *pmi-FormatIndicator= subbandPMI* or *cqi-FormatIndicator=subbandCQI***

|                                 |                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report #n<br>Part 2 subband | Subband differential CQI for the second TB of all even subbands with increasing order of subband number, as in Tables 6.3.1.1.2-3/4/5, if <i>cqi-FormatIndicator=subbandCQI</i> and if reported                                                                                                                                                                |
|                                 | PMI subband information fields $X_2$ of all even subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1/2, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214] of all even subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI</i> and if reported |
|                                 | Subband differential CQI for the second TB of all odd subbands with increasing order of subband number, as in Tables 6.3.1.1.2-3/4/5, if <i>cqi-FormatIndicator=subbandCQI</i> and if reported                                                                                                                                                                 |
|                                 | PMI subband information fields $X_2$ of all odd subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1/2, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214] of all odd subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI</i> and if reported   |

Note: Subbands for given CSI report  $n$  indicated by the higher layer parameter *csi-ReportingBand* with value set to '1' are numbered continuously in the increasing order with the lowest subband of *csi-ReportingBand* with value set to '1' as subband 0.

**Table 6.3.1.1.2-11A: Mapping order of CSI fields of one CSI report, CSI part 2 subband, *csi-ReportMode= Mode 1***

|                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report #n<br>Part 2 subband | PMI subband information fields $X_2$ of all even subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the first resource within the CSI-RS resource pair, according to Clause 5.2.2.2.1 in [6, TS38.214] of all even subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI</i> and if reported                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                                 | PMI subband information fields $X_2$ of all even subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the second resource within the CSI-RS resource pair, according to Clause 5.2.2.2.1 in [6, TS38.214] of all even subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI</i> and if reported                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|                                 | Subband differential CQI for the second TB of all even subbands with increasing order of subband number associated with CRI in CSI part 1, as in Tables 6.3.1.1.2-3B, if <i>cqi-FormatIndicator=subbandCQI, numberOfSingleTRP-CSI-Mode1 = 1</i> and if reported;<br>Subband differential CQI for the second TB of all even subbands with increasing order of subband number associated with the first CRI in CSI part 1, as in Tables 6.3.1.1.2-3B, if <i>cqi-FormatIndicator=subbandCQI, numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                                 |
|                                 | PMI subband information fields $X_2$ of all even subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with CRI in CSI part 1 according to Clause 5.2.2.2.1 in [6, TS38.214] of all even subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI, numberOfSingleTRP-CSI-Mode1 = 1</i> and if reported;<br>PMI subband information fields $X_2$ of all even subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the first CRI in CSI part 1 according to Clause 5.2.2.2.1 in [6, TS38.214] of all even subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI, numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported |
|                                 | Subband differential CQI for the second TB of all even subbands with increasing order of subband number associated with the second CRI in CSI part 1, as in Tables 6.3.1.1.2-3B, if <i>cqi-FormatIndicator=subbandCQI, numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                 | PMI subband information fields $X_2$ of all even subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the second CRI in CSI part 1 according to Clause 5.2.2.2.1 in [6, TS38.214] of all even subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI, numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                 | PMI subband information fields $X_2$ of all odd subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the first resource within the CSI-RS resource pair, according to Clause 5.2.2.2.1 in [6, TS38.214] of all odd subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI</i> and if reported                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                 | PMI subband information fields $X_2$ of all odd subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the second resource within the CSI-RS resource pair, according to Clause 5.2.2.2.1 in [6, TS38.214] of all odd subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI</i> and if reported                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                 | Subband differential CQI for the second TB of all odd subbands with increasing order of subband number associated with CRI in CSI part 1, as in Tables 6.3.1.1.2-3B, if <i>cqi-FormatIndicator=subbandCQI, numberOfSingleTRP-CSI-Mode1 = 1</i> and if reported;<br>Subband differential CQI for the second TB of all odd subbands with increasing order of subband number associated with the first CRI in CSI part 1, as in Tables 6.3.1.1.2-3B, if <i>cqi-FormatIndicator=subbandCQI, numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                                   |
|                                 | PMI subband information fields $X_2$ of all odd subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with CRI in CSI part 1 according to Clause 5.2.2.2.1 in [6, TS38.214] of all odd subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI, numberOfSingleTRP-CSI-Mode1 = 1</i> and if reported;<br>PMI subband information fields $X_2$ of all odd subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the first CRI in CSI part 1 according to Clause 5.2.2.2.1 in [6, TS38.214] of all                                                                                                                                                      |

|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | odd subbands with increasing order of subband number, if <i>pmi-FormatIndicator</i> = <i>subbandPMI</i> , <i>numberOfSingleTRP-CSI-Mode1</i> = 2 and if reported                                                                                                                                                                                                                                                                                         |
|  | Subband differential CQI for the second TB of all odd subbands with increasing order of subband number associated with the second CRI in CSI part 1, as in Tables 6.3.1.1.2-3B, if <i>cqi-FormatIndicator</i> = <i>subbandCQI</i> , <i>numberOfSingleTRP-CSI-Mode1</i> = 2 and if reported                                                                                                                                                               |
|  | PMI subband information fields $X_2$ of all odd subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the second CRI in CSI part 1 according to Clause 5.2.2.2.1 in [6, TS38.214] of all odd subbands with increasing order of subband number, if <i>pmi-FormatIndicator</i> = <i>subbandPMI</i> , <i>numberOfSingleTRP-CSI-Mode1</i> = 2 and if reported |

**Table 6.3.1.1.2-11B: Mapping order of CSI fields of one CSI report, CSI part 2 subband, *csi-ReportMode*= *Mode 2***

|                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report #n<br>Part 2 subband | PMI subband information fields $X_2$ of all even subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the first resource within the CSI-RS resource pair, according to Clause 5.2.2.2.1 in [6, TS38.214] of all even subbands with increasing order of subband number, if <i>pmi-FormatIndicator</i> = <i>subbandPMI</i> and reported part 1 is associated with one CSI-RS resource pair and if reported  |
|                                 | PMI subband information fields $X_2$ of all even subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the second resource within the CSI-RS resource pair, according to Clause 5.2.2.2.1 in [6, TS38.214] of all even subbands with increasing order of subband number, if <i>pmi-FormatIndicator</i> = <i>subbandPMI</i> and reported part 1 is associated with one CSI-RS resource pair and if reported |
|                                 | PMI subband information fields $X_2$ of all odd subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the first resource within the CSI-RS resource pair, according to Clause 5.2.2.2.1 in [6, TS38.214] of all odd subbands with increasing order of subband number, if <i>pmi-FormatIndicator</i> = <i>subbandPMI</i> and reported part 1 is associated with one CSI-RS resource pair and if reported    |
|                                 | PMI subband information fields $X_2$ of all odd subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the second resource within the CSI-RS resource pair, according to Clause 5.2.2.2.1 in [6, TS38.214] of all odd subbands with increasing order of subband number, if <i>pmi-FormatIndicator</i> = <i>subbandPMI</i> and reported part 1 is associated with one CSI-RS resource pair and if reported   |
|                                 | Subband differential CQI for the second TB of all even subbands with increasing order of subband number associated with one CSI-RS resource, as in Tables 6.3.1.1.2-3B, if <i>cqi-FormatIndicator</i> = <i>subbandCQI</i> and reported part 1 is associated with one CSI-RS resource and if reported                                                                                                                                                                                                      |
|                                 | PMI subband information fields $X_2$ of all even subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with one CSI-RS resource according to Clause 5.2.2.2.1 in [6, TS38.214] of all even subbands with increasing order of subband number, if <i>pmi-FormatIndicator</i> = <i>subbandPMI</i> and reported part 1 is associated with one CSI-RS resource and if reported                                       |
|                                 | Subband differential CQI for the second TB of all odd subbands with increasing order of subband number associated with one CSI-RS resource, as in Tables 6.3.1.1.2-3B, if <i>cqi-FormatIndicator</i> = <i>subbandCQI</i> and reported part 1 is associated with one CSI-RS resource and if reported                                                                                                                                                                                                       |
|                                 | PMI subband information fields $X_2$ of all odd subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with one CSI-RS resource according to Clause 5.2.2.2.1 in [6, TS38.214] of all odd subbands with increasing order of subband number, if <i>pmi-FormatIndicator</i> = <i>subbandPMI</i> and reported part 1 is associated with one CSI-RS resource and if reported                                         |

If none of the CSI reports for transmission on a PUCCH is of two parts, the CSI fields of all CSI reports, in the order from upper part to lower part in Table 6.3.1.1.2-12, are mapped to the UCI bit sequence  $a_0, a_1, a_2, a_3, \dots, a_{A-1}$  starting



with  $a_0$ . The most significant bit of each field is mapped to the lowest order information bit for that field, e.g. the most significant bit of the first field is mapped to  $a_0$ .

**Table 6.3.1.1.2-12: Mapping order of CSI reports to UCI bit sequence  $a_0, a_1, a_2, a_3, \dots, a_{A-1}$ , without two-part CSI report(s)**

| UCI bit sequence | CSI report number                                |
|------------------|--------------------------------------------------|
| $a_0$            | CSI report #1<br>as in Table 6.3.1.1.2-7/7A/8/8B |
| $a_1$            | CSI report #2<br>as in Table 6.3.1.1.2-7/7A/8/8B |
| $a_2$            | ...                                              |
| $a_3$            | ...                                              |
| $\vdots$         | ...                                              |
| $a_{A-1}$        | CSI report #n<br>as in Table 6.3.1.1.2-7/7A/8/8B |

If at least one of the CSI reports for transmission on a PUCCH is of two parts, two UCI bit sequences are generated,  $a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{A^{(1)}-1}^{(1)}$  and  $a_0^{(2)}, a_1^{(2)}, a_2^{(2)}, a_3^{(2)}, \dots, a_{A^{(2)}-1}^{(2)}$ . The CSI fields of all CSI reports, in the order from upper part to lower part in Table 6.3.1.1.2-13, are mapped to the UCI bit sequence  $a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{A^{(1)}-1}^{(1)}$  starting with  $a_0^{(1)}$ . The most significant bit of each field is mapped to the lowest order information bit for that field, e.g. the most significant bit of the first field is mapped to  $a_0^{(1)}$ . The CSI fields of all CSI reports, in the order from upper part to lower part in Table 6.3.1.1.2-14, are mapped to the UCI bit sequence  $a_0^{(2)}, a_1^{(2)}, a_2^{(2)}, a_3^{(2)}, \dots, a_{A^{(2)}-1}^{(2)}$  starting with  $a_0^{(2)}$ . The most significant bit of each field is mapped to the lowest order information bit for that field, e.g. the most significant bit of the first field is mapped to  $a_0^{(2)}$ . If the length of UCI bit sequence  $a_0^{(2)}, a_1^{(2)}, a_2^{(2)}, a_3^{(2)}, \dots, a_{A^{(2)}-1}^{(2)}$  is less than 3 bits, zeros shall be appended to the UCI bit sequence until its length equals 3.

**Table 6.3.1.1.2-13: Mapping order of CSI reports to UCI bit sequence  $a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{A^{(1)}-1}^{(1)}$ , with two-part CSI report(s)**

| UCI bit sequence      | CSI report number                                                                                                                                                 |
|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $a_0^{(1)}$           | CSI report #1 if CSI report #1 is not of two parts, or<br>CSI report #1, CSI part 1, if CSI report #1 is of two parts,<br>as in Table 6.3.1.1.2-7/7A/8/8B/9/9A/9B |
| $a_1^{(1)}$           | CSI report #2 if CSI report #2 is not of two parts, or<br>CSI report #2, CSI part 1, if CSI report #2 is of two parts,<br>as in Table 6.3.1.1.2-7/7A/8/8B/9/9A/9B |
| $a_2^{(1)}$           | ...                                                                                                                                                               |
| $a_3^{(1)}$           | ...                                                                                                                                                               |
| $\vdots$              | ...                                                                                                                                                               |
| $a_{A^{(1)}-1}^{(1)}$ | CSI report #n if CSI report #n is not of two parts, or<br>CSI report #n, CSI part 1, if CSI report #n is of two parts,<br>as in Table 6.3.1.1.2-7/7A/8/8B/9/9A/9B |

where CSI report #1, CSI report #2, ..., CSI report #n in Table 6.3.1.1.2-13 correspond to the CSI reports in increasing order of CSI report priority values according to Clause 5.2.5 of [6, TS38.214].

**Table 6.3.1.1.2-14: Mapping order of CSI reports to UCI bit sequence  $a_0^{(2)}, a_1^{(2)}, a_2^{(2)}, a_3^{(2)}, \dots, a_{A^{(2)}-1}^{(2)}$ , with two-part CSI report(s)**

| UCI bit sequence                                                                              | CSI report number                                                                                              |
|-----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| $a_0^{(2)}$<br>$a_1^{(2)}$<br>$a_2^{(2)}$<br>$a_3^{(2)}$<br>$\vdots$<br>$a_{A^{(2)}-1}^{(2)}$ | CSI report #1, CSI part 2 wideband, as in Table 6.3.1.1.2-10/10A/10B<br>if CSI part 2 exists for CSI report #1 |
|                                                                                               | CSI report #2, CSI part 2 wideband, as in Table 6.3.1.1.2-10/10A/10B<br>if CSI part 2 exists for CSI report #2 |
|                                                                                               | ...                                                                                                            |
|                                                                                               | CSI report #n, CSI part 2 wideband, as in Table 6.3.1.1.2-10/10A/10B<br>if CSI part 2 exists for CSI report #n |
|                                                                                               | CSI report #1, CSI part 2 subband, as in Table 6.3.1.1.2-11/11A/11B<br>if CSI part 2 exists for CSI report #1  |
|                                                                                               | CSI report #2, CSI part 2 subband, as in Table 6.3.1.1.2-11/11A/11B<br>if CSI part 2 exists for CSI report #2  |
|                                                                                               | ...                                                                                                            |
|                                                                                               | CSI report #n, CSI part 2 subband, as in Table 6.3.1.1.2-11/11A/11B<br>if CSI part 2 exists for CSI report #n  |

where CSI report #1, CSI report #2, ..., CSI report #n in Table 6.3.1.1.2-14 correspond to the CSI reports in increasing order of CSI report priority values according to Clause 5.2.5 of [6, TS38.214].

### 6.3.1.1.3 HARQ-ACK/SR and CSI

If none of the CSI reports for transmission on a PUCCH is of two parts, the UCI bit sequence  $a_0, a_1, a_2, a_3, \dots, a_{A-1}$  is generated according to the following, where  $A = O^{\text{ACK}} + O^{\text{SR}} + O^{\text{CSI}}$ :

- if there is HARQ-ACK for transmission on the PUCCH, the HARQ-ACK bits are mapped to the UCI bit sequence  $a_0, a_1, a_2, a_3, \dots, a_{O^{\text{ACK}}-1}$ , where  $a_i = \tilde{o}_i^{\text{ACK}}$  for  $i = 0, 1, \dots, O^{\text{ACK}} - 1$ , the HARQ-ACK bit sequence  $\tilde{o}_0^{\text{ACK}}, \tilde{o}_1^{\text{ACK}}, \dots, \tilde{o}_{O^{\text{ACK}}-1}^{\text{ACK}}$  is given by Clause 9.1 of [5, TS38.213], and  $O^{\text{ACK}}$  is number of HARQ-ACK bits; if there is no HARQ-ACK for transmission on the PUCCH, set  $O^{\text{ACK}} = 0$ ;
- if there is SR for transmission on the PUCCH, set  $a_i = \tilde{o}_{i-O^{\text{ACK}}}^{\text{SR}}$  for  $i = O^{\text{ACK}}, O^{\text{ACK}} + 1, \dots, O^{\text{ACK}} + O^{\text{SR}} - 1$ , where the SR bit sequence  $\tilde{o}_0^{\text{SR}}, \tilde{o}_1^{\text{SR}}, \dots, \tilde{o}_{O^{\text{SR}}-1}^{\text{SR}}$  is given by Clause 9.2.5.1 of [5, TS 38.213]; if there is no SR for transmission on the PUCCH, set  $O^{\text{SR}} = 0$ ;
- the CSI fields of all CSI reports, in the order from upper part to lower part in Table 6.3.1.1.2-12, are mapped to the UCI bit sequence  $a_{O^{\text{ACK}}+O^{\text{SR}}}, a_{O^{\text{ACK}}+O^{\text{SR}}+1}, \dots, a_{O^{\text{ACK}}+O^{\text{SR}}+O^{\text{CSI}}-1}$  starting with  $a_{O^{\text{ACK}}+O^{\text{SR}}}$ , where  $O^{\text{CSI}}$  is the number of CSI bits.

If at least one of the CSI reports for transmission on a PUCCH is of two parts, two UCI bit sequences are generated,  $a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{A^{(1)}-1}^{(1)}$  and  $a_0^{(2)}, a_1^{(2)}, a_2^{(2)}, a_3^{(2)}, \dots, a_{A^{(2)}-1}^{(2)}$ , according to the following, where

$$A^{(1)} = O^{\text{ACK}} + O^{\text{SR}} + O^{\text{CSI-part1}} \text{ and } A^{(2)} = O^{\text{CSI-part2}};$$

- if there is HARQ-ACK for transmission on the PUCCH, the HARQ-ACK bits are mapped to the UCI bit sequence  $a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{O^{\text{ACK}}-1}^{(1)}$ , where  $a_i^{(1)} = \tilde{o}_i^{\text{ACK}}$  for  $i = 0, 1, \dots, O^{\text{ACK}} - 1$ , the HARQ-ACK bit sequence

$\tilde{o}_0^{ACK}, \tilde{o}_1^{ACK}, \dots, \tilde{o}_{O^{ACK}-1}^{ACK}$  is given by Clause 9.1 of [5, TS38.213], and  $O^{ACK}$  is number of HARQ-ACK bits; if there is no HARQ-ACK for transmission on the PUCCH, set  $O^{ACK} = 0$ ;

- if there is SR for transmission on the PUCCH, set  $a_i = \tilde{o}_{i-O^{ACK}}^{SR}$  for  $i = O^{ACK}, O^{ACK} + 1, \dots, O^{ACK} + O^{SR} - 1$ , where the SR bit sequence  $\tilde{o}_0^{SR}, \tilde{o}_1^{SR}, \dots, \tilde{o}_{O^{SR}-1}^{SR}$  is given by Clause 9.2.5.1 of [5, TS 38.213]; if there is no SR for transmission on the PUCCH, set  $O^{SR} = 0$ ;
- the CSI fields of all CSI reports, in the order from upper part to lower part in Table 6.3.1.1.2-13, are mapped to the UCI bit sequence  $a_{O^{ACK}+O^{SR}}^{(1)}, a_{O^{ACK}+O^{SR}+1}^{(1)}, \dots, a_{O^{ACK}+O^{SR}+O^{CSI-part1}-1}^{(1)}$  starting with  $a_{O^{ACK}+O^{SR}}^{(1)}$ , where  $O^{CSI-part1}$  is the number of CSI bits in CSI part 1 of all CSI reports;
- the CSI fields of all CSI reports, in the order from upper part to lower part in Table 6.3.1.1.2-14, are mapped to the UCI bit sequence  $a_0^{(2)}, a_1^{(2)}, a_2^{(2)}, a_3^{(2)}, \dots, a_{A^{(2)}-1}^{(2)}$  starting with  $a_0^{(2)}$ , where  $O^{CSI-part2}$  is the number of CSI bits in CSI part 2 of all CSI reports. If the length of UCI bit sequence  $a_0^{(2)}, a_1^{(2)}, a_2^{(2)}, a_3^{(2)}, \dots, a_{A^{(2)}-1}^{(2)}$  is less than 3 bits, zeros shall be appended to the UCI bit sequence until its length equals 3.

#### 6.3.1.1.4 UCI with different priority indexes

If *uci-MuxWithDiffPrio* is configured, and HARQ-ACK bits associated with priority index 0, HARQ-ACK bits associated with priority index 1, and SR associated with priority index 1 if any are transmitted on a PUCCH, two UCI bit sequences are generated,  $a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{A^{(1)}-1}^{(1)}$  and  $a_0^{(2)}, a_1^{(2)}, a_2^{(2)}, a_3^{(2)}, \dots, a_{A^{(2)}-1}^{(2)}$ , according to the following, where  $A^{(1)} = O^{ACK-HP} + O^{SR-HP}$  and  $A^{(2)} = O^{ACK-LP}$ :

- the HARQ-ACK bits associated with priority index 1 are mapped to the UCI bit sequence  $a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{O^{ACK-HP}-1}^{(1)}$ , where  $a_i^{(1)} = \tilde{o}_i^{ACK-HP}$  for  $i = 0, 1, \dots, O^{ACK-HP} - 1$ , the HARQ-ACK bit sequence  $\tilde{o}_0^{ACK-HP}, \tilde{o}_1^{ACK-HP}, \dots, \tilde{o}_{O^{ACK-HP}-1}^{ACK-HP}$  is given by Clause 9.1 of [5, TS 38.213], and  $O^{ACK-HP}$  is the number of HARQ-ACK bits associated with priority index 1;
- if there is SR associated with priority index 1 for transmission on the PUCCH, set  $a_i^{(1)} = \tilde{o}_{i-O^{ACK-HP}}^{SR-HP}$  for  $i = O^{ACK-HP}, O^{ACK-HP} + 1, \dots, O^{ACK-HP} + O^{SR-HP} - 1$ , where the SR bit sequence  $\tilde{o}_0^{SR-HP}, \tilde{o}_1^{SR-HP}, \dots, \tilde{o}_{O^{SR-HP}-1}^{SR-HP}$  is given by Clause 9.2.5.1 of [5, TS 38.213]; if there is no SR associated with priority index 1 for transmission on the PUCCH, set  $O^{SR-HP} = 0$ ;
- the HARQ-ACK bits associated with priority index 0 are mapped to the UCI bit sequence  $a_0^{(2)}, a_1^{(2)}, a_2^{(2)}, a_3^{(2)}, \dots, a_{O^{ACK-LP}-1}^{(2)}$ , where  $a_i^{(2)} = \tilde{o}_i^{ACK-LP}$  for  $i = 0, 1, \dots, O^{ACK-LP} - 1$ , the HARQ-ACK bit sequence  $\tilde{o}_0^{ACK-LP}, \tilde{o}_1^{ACK-LP}, \dots, \tilde{o}_{O^{ACK-LP}-1}^{ACK-LP}$  is given by Clause 9.1 of [5, TS 38.213], and  $O^{ACK-LP}$  is the number of HARQ-ACK bits associated with priority index 0.

#### 6.3.1.2 Code block segmentation and CRC attachment

The UCI bit sequence from clause 6.3.1.1 is denoted by  $a_0, a_1, a_2, a_3, \dots, a_{A-1}$ , where  $A$  is the payload size. The procedure in 6.3.1.2.1 applies for  $A \geq 12$  and the procedure in Clause 6.3.1.2.2 applies for  $A \leq 11$ .

##### 6.3.1.2.1 UCI encoded by Polar code

If the payload size  $A \geq 12$ , code block segmentation and CRC attachment is performed according to Clause 5.2.1. If ( $A \geq 360$  and  $E \geq 1088$ ) or if  $A \geq 1013$ ,  $I_{seg} = 1$ ; otherwise  $I_{seg} = 0$ , where  $E$  is the rate matching output sequence length as given in Clauses 6.3.1.4.1 and 6.3.1.4.3.

If  $12 \leq A \leq 19$ , the parity bits  $p_{r0}, p_{r1}, p_{r2}, \dots, p_{r(L-1)}$  in Clause 5.2.1 are computed by setting  $L$  to 6 bits and using the generator polynomial  $g_{CRC6}(D)$  in Clause 5.1, resulting in the sequence  $c_{r0}, c_{r1}, c_{r2}, c_{r3}, \dots, c_{r(K_r-1)}$  where  $r$  is the code block number and  $K_r$  is the number of bits for code block number  $r$ .

If  $A \geq 20$ , the parity bits  $p_{r0}, p_{r1}, p_{r2}, \dots, p_{r(L-1)}$  in Clause 5.2.1 are computed by setting  $L$  to 11 bits and using the generator polynomial  $g_{\text{CRC11}}(D)$  in Clause 5.1, resulting in the sequence  $c_{r0}, c_{r1}, c_{r2}, c_{r3}, \dots, c_{r(K_r-1)}$  where  $r$  is the code block number and  $K_r$  is the number of bits for code block number  $r$ .

#### 6.3.1.2.2 UCI encoded by channel coding of small block lengths

If the payload size  $A \leq 11$ , CRC bits are not attached.

The output bit sequence is denoted by  $c_0, c_1, c_2, c_3, \dots, c_{K-1}$ , where  $c_i = a_i$  for  $i = 0, 1, \dots, A-1$  and  $K = A$ .

### 6.3.1.3 Channel coding of UCI

#### 6.3.1.3.1 UCI encoded by Polar code

Information bits are delivered to the channel coding block. They are denoted by  $c_{r0}, c_{r1}, c_{r2}, c_{r3}, \dots, c_{r(K_r-1)}$ , where  $r$  is the code block number, and  $K_r$  is the number of bits in code block number  $r$ . The total number of code blocks is denoted by  $C$  and each code block is individually encoded by the following:

If  $18 \leq K_r \leq 25$ , the information bits are encoded via Polar coding according to Clause 5.3.1, by setting  $n_{\text{max}} = 10$ ,  $I_{\text{IL}} = 0$ ,  $n_{\text{PC}} = 3$ ,  $n_{\text{PC}}^{\text{wm}} = 1$  if  $E_r - K_r + 3 > 192$  and  $n_{\text{PC}}^{\text{wm}} = 0$  if  $E_r - K_r + 3 \leq 192$ , where  $E_r$  is the rate matching output sequence length as given in Clauses 6.3.1.4.1 and 6.3.1.4.3.

If  $K_r > 30$ , the information bits are encoded via Polar coding according to Clause 5.3.1, by setting  $n_{\text{max}} = 10$ ,  $I_{\text{IL}} = 0$ ,  $n_{\text{PC}} = 0$ , and  $n_{\text{PC}}^{\text{wm}} = 0$ .

After encoding the bits are denoted by  $d_{r0}, d_{r1}, d_{r2}, d_{r3}, \dots, d_{r(N_r-1)}$ , where  $N_r$  is the number of coded bits in code block number  $r$ .

#### 6.3.1.3.2 UCI encoded by channel coding of small block lengths

Information bits are delivered to the channel coding block. They are denoted by  $c_0, c_1, c_2, c_3, \dots, c_{K-1}$ , where  $K$  is the number of bits.

The information bits are encoded according to Clause 5.3.3.

After encoding the bits are denoted by  $d_0, d_1, d_2, d_3, \dots, d_{N-1}$ , where  $N$  is the number of coded bits.

### 6.3.1.4 Rate matching

For PUCCH formats 2/3/4, the total rate matching output sequence length  $E_{\text{tot}}$  is given by Table 6.3.1.4-1, where

$N_{\text{symb,UCI}}^{\text{PUCCH2}}$ ,  $N_{\text{symb,UCI}}^{\text{PUCCH3}}$  and  $N_{\text{symb,UCI}}^{\text{PUCCH4}}$  are the number of symbols carrying UCI for PUCCH formats 2/3/4 respectively;  $N_{\text{PRB}}^{\text{PUCCH,2}}$ ,  $N_{\text{PRB}}^{\text{PUCCH,3}}$  and  $N_{\text{PRB}}^{\text{PUCCH,4}}$  are the number of PRBs that are determined by the UE for PUCCH formats 2/3/4 transmission respectively according to Clause 9.2 of [5, TS38.213]; and  $N_{\text{SF}}^{\text{PUCCH,2}}$ ,  $N_{\text{SF}}^{\text{PUCCH,3}}$  and  $N_{\text{SF}}^{\text{PUCCH,4}}$  are the spreading factors for PUCCH format 2, PUCCH format 3, and PUCCH format 4, respectively.

**Table 6.3.1.4-1: Total rate matching output sequence length  $E_{\text{tot}}$**

| PUCCH format   | Modulation order                                                                                                       |                                                                                                                        |
|----------------|------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
|                | QPSK                                                                                                                   | $\pi/2$ -BPSK                                                                                                          |
| PUCCH format 2 | $16 \cdot N_{\text{symb,UCI}}^{\text{PUCCH,2}} \cdot N_{\text{PRB}}^{\text{PUCCH,2}} / N_{\text{SF}}^{\text{PUCCH,2}}$ | N/A                                                                                                                    |
| PUCCH format 3 | $24 \cdot N_{\text{symb,UCI}}^{\text{PUCCH,3}} \cdot N_{\text{PRB}}^{\text{PUCCH,3}} / N_{\text{SF}}^{\text{PUCCH,3}}$ | $12 \cdot N_{\text{symb,UCI}}^{\text{PUCCH,3}} \cdot N_{\text{PRB}}^{\text{PUCCH,3}} / N_{\text{SF}}^{\text{PUCCH,3}}$ |
| PUCCH format 4 | $24 \cdot N_{\text{symb,UCI}}^{\text{PUCCH,4}} \cdot N_{\text{PRB}}^{\text{PUCCH,4}} / N_{\text{SF}}^{\text{PUCCH,4}}$ | $12 \cdot N_{\text{symb,UCI}}^{\text{PUCCH,4}} \cdot N_{\text{PRB}}^{\text{PUCCH,4}} / N_{\text{SF}}^{\text{PUCCH,4}}$ |

#### 6.3.1.4.1 UCI encoded by Polar code

The input bit sequence to rate matching is  $d_{r0}, d_{r1}, d_{r2}, d_{r3}, \dots, d_{r(N_r-1)}$  where  $r$  is the code block number, and  $N_r$  is the number of coded bits in code block number  $r$ .

**Table 6.3.1.4.1-1: Rate matching output sequence length  $E_{\text{UCI}}$**

| UCI(s) for transmission on a PUCCH       | UCI for encoding         | Value of $E_{\text{UCI}}$                                                                                                                                                         |
|------------------------------------------|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| HARQ-ACK                                 | HARQ-ACK                 | $E_{\text{UCI}} = E_{\text{tot}}$                                                                                                                                                 |
| HARQ-ACK, SR                             | HARQ-ACK, SR             | $E_{\text{UCI}} = E_{\text{tot}}$                                                                                                                                                 |
| CSI (CSI not of two parts)               | CSI                      | $E_{\text{UCI}} = E_{\text{tot}}$                                                                                                                                                 |
| HARQ-ACK, CSI (CSI not of two parts)     | HARQ-ACK, CSI            | $E_{\text{UCI}} = E_{\text{tot}}$                                                                                                                                                 |
| HARQ-ACK, SR, CSI (CSI not of two parts) | HARQ-ACK, SR, CSI        | $E_{\text{UCI}} = E_{\text{tot}}$                                                                                                                                                 |
| CSI (CSI of two parts)                   | CSI part 1               | $E_{\text{UCI}} = \min(E_{\text{tot}}, \lceil (O^{\text{CSI-part1}} + L) / R_{\text{UCI}}^{\text{max}} / Q_m \rceil \cdot Q_m)$                                                   |
|                                          | CSI part 2               | $E_{\text{UCI}} = E_{\text{tot}} - \min(E_{\text{tot}}, \lceil (O^{\text{CSI-part1}} + L) / R_{\text{UCI}}^{\text{max}} / Q_m \rceil \cdot Q_m)$                                  |
| HARQ-ACK, CSI (CSI of two parts)         | HARQ-ACK, CSI part 1     | $E_{\text{UCI}} = \min(E_{\text{tot}}, \lceil (O^{\text{ACK}} + O^{\text{CSI-part1}} + L) / R_{\text{UCI}}^{\text{max}} / Q_m \rceil \cdot Q_m)$                                  |
|                                          | CSI part 2               | $E_{\text{UCI}} = E_{\text{tot}} - \min(E_{\text{tot}}, \lceil (O^{\text{ACK}} + O^{\text{CSI-part1}} + L) / R_{\text{UCI}}^{\text{max}} / Q_m \rceil \cdot Q_m)$                 |
| HARQ-ACK, SR, CSI (CSI of two parts)     | HARQ-ACK, SR, CSI part 1 | $E_{\text{UCI}} = \min(E_{\text{tot}}, \lceil (O^{\text{ACK}} + O^{\text{SR}} + O^{\text{CSI-part1}} + L) / R_{\text{UCI}}^{\text{max}} / Q_m \rceil \cdot Q_m)$                  |
|                                          | CSI part 2               | $E_{\text{UCI}} = E_{\text{tot}} - \min(E_{\text{tot}}, \lceil (O^{\text{ACK}} + O^{\text{SR}} + O^{\text{CSI-part1}} + L) / R_{\text{UCI}}^{\text{max}} / Q_m \rceil \cdot Q_m)$ |

Rate matching is performed according to Clause 5.4.1 by setting  $I_{\text{BL}} = 1$  and the rate matching output sequence length to  $E_r = \lfloor E_{\text{UCI}} / C_{\text{UCI}} \rfloor$ , where  $C_{\text{UCI}}$  is the number of code blocks for UCI determined according to Clause 6.3.1.2.1 and the value of  $E_{\text{UCI}}$  is given by Table 6.3.1.4.1-1:

- $O^{\text{ACK}}$  is the number of bits for HARQ-ACK for transmission on the current PUCCH;
- $O^{\text{SR}}$  is the number of bits for SR for transmission on the current PUCCH;
- $O^{\text{CSI-part1}}$  is the number of bits for CSI part 1 for transmission on the current PUCCH;
- $O^{\text{CSI-part2}}$  is the number of bits for CSI part 2 for transmission on the current PUCCH;
- if  $A \geq 360$ ,  $L = 11$ ; otherwise,  $L$  is the number of CRC bits determined according to clause 6.3.1.2.1, where  $A$  equals  $O^{\text{CSI-part1}}$  for "CSI (CSI of two parts)", equals  $O^{\text{ACK}} + O^{\text{CSI-part1}}$  for "HARQ-ACK, CSI (CSI of two parts)", and equals  $O^{\text{ACK}} + O^{\text{SR}} + O^{\text{CSI-part1}}$  for "HARQ-ACK, SR, CSI (CSI of two parts)" respectively in Table 6.3.1.4.1-1;
- $R_{\text{UCI}}^{\text{max}}$  is the configured maximum PUCCH coding rate;
- $E_{\text{tot}}$  is given by Table 6.3.1.4-1.

The output bit sequence after rate matching is denoted as  $f_{r0}, f_{r1}, f_{r2}, \dots, f_{r(E_r-1)}$  where  $E_r$  is the length of rate matching output sequence in code block number  $r$ .

#### 6.3.1.4.2 UCI encoded by channel coding of small block lengths

The input bit sequence to rate matching is  $d_0, d_1, d_2, \dots, d_{N-1}$ .

The value of  $E_{\text{UCI}}$  is determined according to Table 6.3.1.4.1-1 by setting  $L = 0$ .

Rate matching is performed according to Clause 5.4.3 by setting the rate matching output sequence length  $E = E_{\text{UCI}}$ .

The output bit sequence after rate matching is denoted as  $f_0, f_1, f_2, \dots, f_{E-1}$ .

#### 6.3.1.4.3 UCI with different priority indexes encoded by Polar code

The following procedure in this clause 6.3.1.4.3 applies if *uci-MuxWithDiffPrio* is configured, and HARQ-ACK bits associated with priority index 0, HARQ-ACK bits associated with priority index 1 and SR associated with priority index 1 if any are transmitted on a PUCCH.

The input bit sequence to rate matching is  $d_{r0}, d_{r1}, d_{r2}, d_{r3}, \dots, d_{r(N_r-1)}$  where  $r$  is the code block number, and  $N_r$  is the number of coded bits in code block number  $r$ .

**Table 6.3.1.4.3-1: Rate matching output sequence length  $E_{\text{UCI}}$  for UCIs with different priority indexes**

| UCIs for transmission on a PUCCH                                                   | UCI for encoding                                     | Value of $E_{\text{UCI}}$                                                                                                                                           |
|------------------------------------------------------------------------------------|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| HARQ-ACK of priority index 1, HARQ-ACK of priority index 0                         | HARQ-ACK of priority index 1                         | $E_{\text{UCI}} = \min(E_{\text{tot}}, \lceil (O^{\text{ACK-HP}} + L) / R_{\text{UCI}}^{\text{max-HP}} / Q_m \rceil \cdot Q_m)$                                     |
|                                                                                    | HARQ-ACK of priority index 0                         | $E_{\text{UCI}} = E_{\text{tot}} - \min(E_{\text{tot}}, \lceil (O^{\text{ACK-HP}} + L) / R_{\text{UCI}}^{\text{max-HP}} / Q_m \rceil \cdot Q_m)$                    |
| HARQ-ACK of priority index 1, SR of priority index 1, HARQ-ACK of priority index 0 | HARQ-ACK of priority index 1, SR of priority index 1 | $E_{\text{UCI}} = \min(E_{\text{tot}}, \lceil (O^{\text{ACK-HP}} + O^{\text{SR-HP}} + L) / R_{\text{UCI}}^{\text{max-HP}} / Q_m \rceil \cdot Q_m)$                  |
|                                                                                    | HARQ-ACK of priority index 0                         | $E_{\text{UCI}} = E_{\text{tot}} - \min(E_{\text{tot}}, \lceil (O^{\text{ACK-HP}} + O^{\text{SR-HP}} + L) / R_{\text{UCI}}^{\text{max-HP}} / Q_m \rceil \cdot Q_m)$ |

Rate matching is performed according to Clause 5.4.1 by setting  $I_{\text{BIL}} = 1$  and the rate matching output sequence length to  $E_r = \lfloor E_{\text{UCI}} / C_{\text{UCI}} \rfloor$ , where  $C_{\text{UCI}}$  is the number of code blocks for UCI determined according to Clause 6.3.1.2.1 and the value of  $E_{\text{UCI}}$  is given by Table 6.3.1.4.3-1:

- $O^{\text{ACK-HP}}$  is the number of bits for HARQ-ACK associated with priority index 1 for transmission on the current PUCCH;
- $O^{\text{SR-HP}}$  is the number of bits for SR associated with priority index 1 for transmission on the current PUCCH;
- if  $A \geq 360$ ,  $L=11$ ; otherwise,  $L$  is the number of CRC bits determined according to clause 6.3.1.2.1, where  $A$  equals  $O^{\text{ACK-HP}}$  for the case of "HARQ-ACK of priority index 1, HARQ-ACK of priority index 0", and equals  $O^{\text{ACK-HP}} + O^{\text{SR-HP}}$  for the case of "HARQ-ACK of priority index 1, SR of priority index 1, HARQ-ACK of priority index 0" respectively in Table 6.3.1.4.3-1;
- $R_{\text{UCI}}^{\text{max-HP}}$  is the configured maximum PUCCH coding rate of priority index 1;
- $E_{\text{tot}}$  is given by Table 6.3.1.4-1.

The output bit sequence after rate matching is denoted as  $f_{r0}, f_{r1}, f_{r2}, \dots, f_{r(E_r-1)}$  where  $E_r$  is the length of rate matching output sequence in code block number  $r$ .

#### 6.3.1.4.4 UCI with different priority indexes encoded by channel coding of small block lengths

The following procedure in this clause 6.3.1.4.4 applies if *uci-MuxWithDiffPrio* is configured, and HARQ-ACK bits associated with priority index 0, HARQ-ACK bits associated with priority index 1 and SR associated with priority index 1 if any are transmitted on a PUCCH.

The input bit sequence to rate matching is  $d_0, d_1, d_2, \dots, d_{N-1}$ .

The value of  $E_{\text{UCI}}$  is determined according to Table 6.3.1.4.3-1 by setting  $L=0$ .

Rate matching is performed according to Clause 5.4.3 by setting the rate matching output sequence length  $E = E_{\text{UCI}}$ .

The output bit sequence after rate matching is denoted as  $f_0, f_1, f_2, \dots, f_{E-1}$ .

### 6.3.1.5 Code block concatenation

The input bit sequence for the code block concatenation block are the sequences  $f_{r0}, f_{r1}, f_{r2}, \dots, f_{r(E_r-1)}$ , for  $r = 0, \dots, C-1$  and where  $E_r$  is the number of rate matched bits for the  $r$ -th code block.

Code block concatenation is performed according to Clause 5.5.

The bits after code block concatenation are denoted by  $g_0, g_1, g_2, g_3, \dots, g_{G'-1}$ , where  $G' = \lfloor E_{\text{UCI}} / C_{\text{UCI}} \rfloor \cdot C_{\text{UCI}}$  with the values of  $E_{\text{UCI}}$  and  $C_{\text{UCI}}$  given in Clauses 6.3.1.4.1 and 6.3.1.4.3. Let  $G$  be the total number of coded bits for transmission and  $G = G' + \text{mod}(E_{\text{UCI}}, C_{\text{UCI}})$ . Set  $g_i = 0$  for  $i = G', G'+1, \dots, G-1$ .

### 6.3.1.6 Multiplexing of coded UCI bits to PUCCH

If CSI of two parts or UCIs with different priority indexes are transmitted on a PUCCH, the coded bits corresponding to UCI bit sequence  $a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{A^{(1)}-1}^{(1)}$  is denoted by  $g_0^{(1)}, g_1^{(1)}, g_2^{(1)}, g_3^{(1)}, \dots, g_{G^{(1)}-1}^{(1)}$  and the coded bits corresponding to UCI bit sequence  $a_0^{(2)}, a_1^{(2)}, a_2^{(2)}, a_3^{(2)}, \dots, a_{A^{(2)}-1}^{(2)}$  is denoted by  $g_0^{(2)}, g_1^{(2)}, g_2^{(2)}, g_3^{(2)}, \dots, g_{G^{(2)}-1}^{(2)}$ .

For PUCCH format 2 when *uci-MuxWithDiffPrio* is configured, the coded bit sequence  $g_0, g_1, g_2, g_3, \dots, g_{G-1}$  is generated for UCIs with different priority indexes by setting  $g_i = g_i^{(1)}$  for  $i = 0, 1, \dots, G^{(1)} - 1$ , and setting  $g_i = g_{i-G^{(1)}}^{(2)}$  for  $i = G^{(1)}, G^{(1)} + 1, \dots, G^{(1)} + G^{(2)} - 1$ .

For PUCCH format 3/4, the coded bit sequence  $g_0, g_1, g_2, g_3, \dots, g_{G-1}$ , where  $G = G^{(1)} + G^{(2)}$ , is generated according to the following.

**Table 6.3.1.6-1: PUCCH DMRS and UCI symbols**

| PUCCH duration (symbols) | PUCCH DMRS symbol indices | Number of UCI symbol indices sets $N_{\text{UCI}}^{\text{set}}$ | 1 <sup>st</sup> UCI symbol indices set $S_{\text{UCI}}^{(1)}$ | 2 <sup>nd</sup> UCI symbol indices set $S_{\text{UCI}}^{(2)}$ | 3 <sup>rd</sup> UCI symbol indices set $S_{\text{UCI}}^{(3)}$ |
|--------------------------|---------------------------|-----------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|
| 4                        | {1}                       | 2                                                               | {0,2}                                                         | {3}                                                           | -                                                             |
| 4                        | {0,2}                     | 1                                                               | {1,3}                                                         | -                                                             | -                                                             |
| 5                        | {0,3}                     | 1                                                               | {1,2,4}                                                       | -                                                             | -                                                             |
| 6                        | {1,4}                     | 1                                                               | {0,2,3,5}                                                     | -                                                             | -                                                             |
| 7                        | {1,4}                     | 2                                                               | {0,2,3,5}                                                     | {6}                                                           | -                                                             |
| 8                        | {1,5}                     | 2                                                               | {0,2,4,6}                                                     | {3,7}                                                         | -                                                             |
| 9                        | {1,6}                     | 2                                                               | {0,2,5,7}                                                     | {3,4,8}                                                       | -                                                             |
| 10                       | {2,7}                     | 2                                                               | {1,3,6,8}                                                     | {0,4,5,9}                                                     | -                                                             |
| 10                       | {1,3,6,8}                 | 1                                                               | {0,2,4,5,7,9}                                                 | -                                                             | -                                                             |
| 11                       | {2,7}                     | 3                                                               | {1,3,6,8}                                                     | {0,4,5,9}                                                     | {10}                                                          |
| 11                       | {1,3,6,9}                 | 1                                                               | {0,2,4,5,7,8,10}                                              | -                                                             | -                                                             |
| 12                       | {2,8}                     | 3                                                               | {1,3,7,9}                                                     | {0,4,6,10}                                                    | {5,11}                                                        |
| 12                       | {1,4,7,10}                | 1                                                               | {0,2,3,5,6,8,9,11}                                            | -                                                             | -                                                             |
| 13                       | {2,9}                     | 3                                                               | {1,3,8,10}                                                    | {0,4,7,11}                                                    | {5,6,12}                                                      |
| 13                       | {1,4,7,11}                | 2                                                               | {0,2,3,5,6,8,10,12}                                           | {9}                                                           | -                                                             |
| 14                       | {3,10}                    | 3                                                               | {2,4,9,11}                                                    | {1,5,8,12}                                                    | {0,6,7,13}                                                    |
| 14                       | {1,5,8,12}                | 2                                                               | {0,2,4,6,7,9,11,13}                                           | {3,10}                                                        | -                                                             |

Denote  $s_i$  as UCI OFDM symbol index. Denote  $N_{\text{UCI}}^{(i)}$  as the number of elements in UCI symbol indices set  $S_{\text{UCI}}^{(i)}$  for  $i = 1, \dots, N_{\text{UCI}}^{\text{set}}$ , where  $S_{\text{UCI}}^{(i)}$  and  $N_{\text{UCI}}^{\text{set}}$  are given by Table 6.3.1.6-1 according to the PUCCH duration and the PUCCH

DMRS configuration. Denote  $N_{\text{symb,UCI}}^{\text{PUCCH}} = \sum_{i=1}^{N_{\text{UCI}}^{\text{set}}} N_{\text{UCI}}^{(i)}$  as the number of OFDM symbols carrying UCI in the PUCCH.

Denote  $Q_m$  as the modulation order of the PUCCH.

For PUCCH formats 3/4, set  $N_{\text{UCI}}^{\text{symbol}} = 12 \cdot N_{\text{PRB}}^{\text{PUCCH},s} / N_{\text{SF}}^{\text{PUCCH},s}$ , where  $N_{\text{PRB}}^{\text{PUCCH},s}$  is the number of PRBs that is determined by the UE for the corresponding PUCCH format transmission according to Clause 9.2 of [5, TS 38.213], and  $N_{\text{SF}}^{\text{PUCCH},s}$  is the spreading factor for the corresponding PUCCH format [4, TS 38.211], where  $s \in \{3,4\}$ .

Find the smallest  $j > 0$  such that  $\left( \sum_{i=1}^j N_{\text{UCI}}^{(i)} \right) \cdot N_{\text{UCI}}^{\text{symbol}} \cdot Q_m \geq G^{(1)}$ .

Set  $n_1 = 0$ ;

Set  $n_2 = 0$ ;

Set  $\bar{N}_{\text{UCI}}^{\text{symbol}} = \left\lceil \left( G^{(1)} - \left( \sum_{i=1}^{j-1} N_{\text{UCI}}^{(i)} \right) \cdot N_{\text{UCI}}^{\text{symbol}} \cdot Q_m \right) / (N_{\text{UCI}}^{(j)} \cdot Q_m) \right\rceil$ ;

Set  $M = \text{mod} \left( \left( G^{(1)} - \left( \sum_{i=1}^{j-1} N_{\text{UCI}}^{(i)} \right) \cdot N_{\text{UCI}}^{\text{symbol}} \cdot Q_m \right) / Q_m, N_{\text{UCI}}^{(j)} \right)$ ;

for  $l = 0$  to  $N_{\text{symb,UCI}}^{\text{PUCCH}} - 1$

if  $s_l \in \bigcup_{i=1}^{j-1} S_{\text{UCI}}^{(i)}$

for  $k = 0$  to  $N_{\text{UCI}}^{\text{symbol}} - 1$

for  $v = 0$  to  $Q_m - 1$

$\bar{g}_{l,k,v} = g_{n_1}^{(1)}$ ;

$n_1 = n_1 + 1$ ;

end for

end for

elseif  $s_l \in S_{\text{UCI}}^{(j)}$

if  $M > 0$

$\gamma = 1$ ;

else

$\gamma = 0$ ;

end if

$M = M - 1$ ;

for  $k = 0$  to  $\bar{N}_{\text{UCI}}^{\text{symbol}} + \gamma - 1$

for  $v = 0$  to  $Q_m - 1$

$\bar{g}_{l,k,v} = g_{n_1}^{(1)}$ ;

$n_1 = n_1 + 1$ ;

end for



end for

for  $k = \overline{N}_{\text{UCI}}^{\text{symbol}} + \gamma$  to  $N_{\text{UCI}}^{\text{symbol}} - 1$

for  $v = 0$  to  $Q_m - 1$

$$\overline{g}_{l,k,v} = g_{n_2}^{(2)};$$

$$n_2 = n_2 + 1;$$

end for

end for

else

for  $k = 0$  to  $N_{\text{UCI}}^{\text{symbol}} - 1$

for  $v = 0$  to  $Q_m - 1$

$$\overline{g}_{l,k,v} = g_{n_2}^{(2)};$$

$$n_2 = n_2 + 1;$$

end for

end for

end if

end for

Set  $n = 0$

for  $l = 0$  to  $N_{\text{symb,UCI}}^{\text{PUCCH}} - 1$

for  $k = 0$  to  $N_{\text{UCI}}^{\text{symbol}} - 1$

for  $v = 0$  to  $Q_m - 1$

$$g_n = \overline{g}_{l,k,v};$$

$$n = n + 1;$$

end for

end for

end for

## 6.3.2 Uplink control information on PUSCH

The following clauses 6.3.2.2, 6.3.2.3, and 6.3.2.5 apply regardless of whether the higher layer parameter *uci-MuxWithDiffPrio* is configured or not. The following clauses 6.3.2.1, 6.3.2.4, and 6.3.2.6 apply by assuming *uci-MuxWithDiffPrio* is not configured, or *uci-MuxWithDiffPrio* is configured and the UCIs for transmission on a PUSCH are of the same priority index, unless stated otherwise.

If the UE is configured with a PUCCH-SCell, *uci-MuxWithDiffPrio* is replaced by *uci-MuxWithDiffPrioSecondaryPUCCHgroup* for the secondary PUCCH group in this clause.

### 6.3.2.1 UCI bit sequence generation

#### 6.3.2.1.1 HARQ-ACK

If HARQ-ACK bits are transmitted on a PUSCH, the UCI bit sequence  $a_0, a_1, a_2, a_3, \dots, a_{A-1}$  is determined as follows:

- If UCI is transmitted on PUSCH without UL-SCH and the UCI includes CSI part 1 without CSI part 2,
- if there is no HARQ-ACK bit given by Clause 9.1 of [5, TS 38.213], set  $a_0 = 0$ ,  $a_1 = 0$ , and  $A = 2$ ;
- if there is only one HARQ-ACK bit  $\tilde{o}_0^{ACK}$  given by Clause 9.1 of [5, TS 38.213], set  $a_0 = \tilde{o}_0^{ACK}$ ,  $a_1 = 0$ , and  $A = 2$ ;
- otherwise, set  $a_i = \tilde{o}_i^{ACK}$  for  $i = 0, 1, \dots, O^{ACK} - 1$  and  $A = O^{ACK}$ , where the HARQ-ACK bit sequence  $\tilde{o}_0^{ACK}, \tilde{o}_1^{ACK}, \dots, \tilde{o}_{O^{ACK}-1}^{ACK}$  is given by Clause 9.1 of [5, TS 38.213].

#### 6.3.2.1.2 CSI

If *cqi-BitsPerSubband* is configured, this Clause 6.3.2.1.2 applies by taking Subband CQI as Subband differential CQI and replacing the corresponding number of bits 2 by 4.

The bitwidth for PMI of *codebookType=typeI-SinglePanel* and *codebookType=typeI-MultiPanel* is specified in Clause 6.3.1.1.2.

The bitwidth for RI/LI/CQI/CRI of *codebookType=typeI-SinglePanel* and *codebookType=typeI-MultiPanel* is specified in Clause 6.3.1.1.2.

The bitwidth for PMI/RI/LI/CQI/CRI with 1 CSI-RS port is specified in Clause 6.3.1.1.2.

The bitwidth for PMI of *codebookType=typeII* is provided in Tables 6.3.2.1.2-1, where the values of  $(N_1, N_2)$ ,  $(O_1, O_2)$ ,  $L$ ,  $N_{\text{PSK}}$ ,  $M_1$ ,  $M_2$ , and  $K^{(2)}$  are given by Clause 5.2.2.2.3 in [6, TS 38.214].

**Table 6.3.2.1.2-1: PMI of *codebookType= typeII***

|                         | Information fields $X_1$ for wideband PMI |                                                      |                            |             |                            |             | Information fields $X_2$ for wideband PMI or per subband PMI                                                  |                                                                                                               |                          |                          |
|-------------------------|-------------------------------------------|------------------------------------------------------|----------------------------|-------------|----------------------------|-------------|---------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------|
|                         | $i_{1,1}$                                 | $i_{1,2}$                                            | $i_{1,3,1}$                | $i_{1,4,1}$ | $i_{1,3,2}$                | $i_{1,4,2}$ | $i_{2,1,1}$                                                                                                   | $i_{2,1,2}$                                                                                                   | $i_{2,2,1}$              | $i_{2,2,2}$              |
| Rank=1<br>SBAmpp<br>off | $\lceil \log_2(O_1 O_2) \rceil$           | $\lceil \log_2\left(\frac{N_1 N_2}{L}\right) \rceil$ | $\lceil \log_2(2L) \rceil$ | $3(2L-1)$   | N/A                        | N/A         | $(M_1-1) \cdot \log_2 N_{\text{PSK}}$                                                                         | N/A                                                                                                           | N/A                      | N/A                      |
| Rank=2<br>SBAmpp<br>off | $\lceil \log_2(O_1 O_2) \rceil$           | $\lceil \log_2\left(\frac{N_1 N_2}{L}\right) \rceil$ | $\lceil \log_2(2L) \rceil$ | $3(2L-1)$   | $\lceil \log_2(2L) \rceil$ | $3(2L-1)$   | $(M_1-1) \cdot \log_2 N_{\text{PSK}}$                                                                         | $(M_2-1) \cdot \log_2 N_{\text{PSK}}$                                                                         | N/A                      | N/A                      |
| Rank=1<br>SBAmpp<br>on  | $\lceil \log_2(O_1 O_2) \rceil$           | $\lceil \log_2\left(\frac{N_1 N_2}{L}\right) \rceil$ | $\lceil \log_2(2L) \rceil$ | $3(2L-1)$   | N/A                        | N/A         | $\min(M_1, K^{(2)}) \cdot \log_2 N_{\text{PSK}} - \log_2 N_{\text{PSK}} + 2 \cdot (M_1 - \min(M_1, K^{(2)}))$ | N/A                                                                                                           | $\min(M_1, K^{(2)}) - 1$ | N/A                      |
| Rank=2<br>SBAmpp<br>on  | $\lceil \log_2(O_1 O_2) \rceil$           | $\lceil \log_2\left(\frac{N_1 N_2}{L}\right) \rceil$ | $\lceil \log_2(2L) \rceil$ | $3(2L-1)$   | $\lceil \log_2(2L) \rceil$ | $3(2L-1)$   | $\min(M_1, K^{(2)}) \cdot \log_2 N_{\text{PSK}} - \log_2 N_{\text{PSK}} + 2 \cdot (M_1 - \min(M_1, K^{(2)}))$ | $\min(M_2, K^{(2)}) \cdot \log_2 N_{\text{PSK}} - \log_2 N_{\text{PSK}} + 2 \cdot (M_2 - \min(M_2, K^{(2)}))$ | $\min(M_1, K^{(2)}) - 1$ | $\min(M_2, K^{(2)}) - 1$ |

The bitwidth for PMI of *codebookType=typeII-r16* is provided in Tables 6.3.2.1.2-1A, where the values of  $(N_1, N_2)$ ,  $(O_1, O_2)$ ,  $L$ ,  $K^{NZ}$ ,  $N_3$ , and  $\{M_l\}_{l=1,\dots,v}$  are given by Clause 5.2.2.2.5 in [6, TS 38.214].

**Table 6.3.2.1.2-1A: PMI of *codebookType= typeII-r16***

|        |               | Information fields $X_1$        |                                                                    |                               |                            |                              |                                                                           |                                                                          |                                                                          |                                                                          |                               |                               |                               |
|--------|---------------|---------------------------------|--------------------------------------------------------------------|-------------------------------|----------------------------|------------------------------|---------------------------------------------------------------------------|--------------------------------------------------------------------------|--------------------------------------------------------------------------|--------------------------------------------------------------------------|-------------------------------|-------------------------------|-------------------------------|
|        |               | $i_{1,1}$                       | $i_{1,2}$                                                          | $i_{1,8,1}$                   | $i_{1,8,2}$                | $i_{1,8,3}$                  | $i_{1,8,4}$                                                               |                                                                          |                                                                          |                                                                          |                               |                               |                               |
| Rank=1 | $N_3 \leq 19$ | $\lceil \log_2(O_1 O_2) \rceil$ | $\left\lceil \log_2 \left( \frac{N_1 N_2}{L} \right) \right\rceil$ | $\lceil \log_2 K^{NZ} \rceil$ | N/A                        | N/A                          | N/A                                                                       |                                                                          |                                                                          |                                                                          |                               |                               |                               |
| Rank=2 | $N_3 \leq 19$ | $\lceil \log_2(O_1 O_2) \rceil$ | $\left\lceil \log_2 \left( \frac{N_1 N_2}{L} \right) \right\rceil$ | $\lceil \log_2(2L) \rceil$    | $\lceil \log_2(2L) \rceil$ | N/A                          | N/A                                                                       |                                                                          |                                                                          |                                                                          |                               |                               |                               |
| Rank=3 | $N_3 \leq 19$ | $\lceil \log_2(O_1 O_2) \rceil$ | $\left\lceil \log_2 \left( \frac{N_1 N_2}{L} \right) \right\rceil$ | $\lceil \log_2(2L) \rceil$    | $\lceil \log_2(2L) \rceil$ | $\lceil \log_2(2L) \rceil$   | N/A                                                                       |                                                                          |                                                                          |                                                                          |                               |                               |                               |
| Rank=4 | $N_3 \leq 19$ | $\lceil \log_2(O_1 O_2) \rceil$ | $\left\lceil \log_2 \left( \frac{N_1 N_2}{L} \right) \right\rceil$ | $\lceil \log_2(2L) \rceil$    | $\lceil \log_2(2L) \rceil$ | $\lceil \log_2(2L) \rceil$   | $\lceil \log_2(2L) \rceil$                                                |                                                                          |                                                                          |                                                                          |                               |                               |                               |
| Rank=1 | $N_3 > 19$    | $\lceil \log_2(O_1 O_2) \rceil$ | $\left\lceil \log_2 \left( \frac{N_1 N_2}{L} \right) \right\rceil$ | $\lceil \log_2 K^{NZ} \rceil$ | N/A                        | N/A                          | N/A                                                                       |                                                                          |                                                                          |                                                                          |                               |                               |                               |
| Rank=2 | $N_3 > 19$    | $\lceil \log_2(O_1 O_2) \rceil$ | $\left\lceil \log_2 \left( \frac{N_1 N_2}{L} \right) \right\rceil$ | $\lceil \log_2(2L) \rceil$    | $\lceil \log_2(2L) \rceil$ | N/A                          | N/A                                                                       |                                                                          |                                                                          |                                                                          |                               |                               |                               |
| Rank=3 | $N_3 > 19$    | $\lceil \log_2(O_1 O_2) \rceil$ | $\left\lceil \log_2 \left( \frac{N_1 N_2}{L} \right) \right\rceil$ | $\lceil \log_2(2L) \rceil$    | $\lceil \log_2(2L) \rceil$ | $\lceil \log_2(2L) \rceil$   | N/A                                                                       |                                                                          |                                                                          |                                                                          |                               |                               |                               |
| Rank=4 | $N_3 > 19$    | $\lceil \log_2(O_1 O_2) \rceil$ | $\left\lceil \log_2 \left( \frac{N_1 N_2}{L} \right) \right\rceil$ | $\lceil \log_2(2L) \rceil$    | $\lceil \log_2(2L) \rceil$ | $\lceil \log_2(2L) \rceil$   | $\lceil \log_2(2L) \rceil$                                                |                                                                          |                                                                          |                                                                          |                               |                               |                               |
|        |               | Information fields $X_2$        |                                                                    |                               |                            |                              |                                                                           |                                                                          |                                                                          |                                                                          |                               |                               |                               |
|        |               | $i_{2,3,1}$                     | $i_{2,3,2}$                                                        | $i_{2,3,3}$                   | $i_{2,3,4}$                | $i_{1,5}$                    | $i_{1,6,1}$                                                               | $i_{1,6,2}$                                                              | $i_{1,6,3}$                                                              | $i_{1,6,4}$                                                              | $\{i_{2,4,l}\}_{l=1,\dots,v}$ | $\{i_{2,5,l}\}_{l=1,\dots,v}$ | $\{i_{1,7,l}\}_{l=1,\dots,v}$ |
| Rank=1 | $N_3 \leq 19$ | 4                               | N/A                                                                | N/A                           | N/A                        | N/A                          | $\left\lceil \log_2 \left( \frac{N_3 - 1}{M_1 - 1} \right) \right\rceil$  | N/A                                                                      | N/A                                                                      | N/A                                                                      | $3(K^{NZ} - 1)$               | $4(K^{NZ} - 1)$               | $2LM_1$                       |
| Rank=2 | $N_3 \leq 19$ | 4                               | 4                                                                  | N/A                           | N/A                        | N/A                          | $\left\lceil \log_2 \left( \frac{N_3 - 1}{M_2 - 1} \right) \right\rceil$  | $\left\lceil \log_2 \left( \frac{N_3 - 1}{M_2 - 1} \right) \right\rceil$ | N/A                                                                      | N/A                                                                      | $3(K^{NZ} - 2)$               | $4(K^{NZ} - 2)$               | $4LM_2$                       |
| Rank=3 | $N_3 \leq 19$ | 4                               | 4                                                                  | 4                             | N/A                        | N/A                          | $\left\lceil \log_2 \left( \frac{N_3 - 1}{M_3 - 1} \right) \right\rceil$  | $\left\lceil \log_2 \left( \frac{N_3 - 1}{M_3 - 1} \right) \right\rceil$ | $\left\lceil \log_2 \left( \frac{N_3 - 1}{M_3 - 1} \right) \right\rceil$ | N/A                                                                      | $3(K^{NZ} - 3)$               | $4(K^{NZ} - 3)$               | $6LM_3$                       |
| Rank=4 | $N_3 \leq 19$ | 4                               | 4                                                                  | 4                             | 4                          | N/A                          | $\left\lceil \log_2 \left( \frac{N_3 - 1}{M_4 - 1} \right) \right\rceil$  | $\left\lceil \log_2 \left( \frac{N_3 - 1}{M_4 - 1} \right) \right\rceil$ | $\left\lceil \log_2 \left( \frac{N_3 - 1}{M_4 - 1} \right) \right\rceil$ | $\left\lceil \log_2 \left( \frac{N_3 - 1}{M_4 - 1} \right) \right\rceil$ | $3(K^{NZ} - 4)$               | $4(K^{NZ} - 4)$               | $8LM_4$                       |
| Rank=1 | $N_3 > 19$    | 4                               | N/A                                                                | N/A                           | N/A                        | $\lceil \log_2(2M_1) \rceil$ | $\left\lceil \log_2 \left( \frac{2M_1 - 1}{M_1 - 1} \right) \right\rceil$ | N/A                                                                      | N/A                                                                      | N/A                                                                      | $3(K^{NZ} - 1)$               | $4(K^{NZ} - 1)$               | $2LM_1$                       |

|                              |   |   |     |     |                              |                                                                |                                                                |                                                                |                                                                |                 |                 |         |
|------------------------------|---|---|-----|-----|------------------------------|----------------------------------------------------------------|----------------------------------------------------------------|----------------------------------------------------------------|----------------------------------------------------------------|-----------------|-----------------|---------|
| Rank=<br>2<br><br>$N_3 > 19$ | 4 | 4 | N/A | N/A | $\lceil \log_2(2M_2) \rceil$ | $\lceil \log_2 \left( \frac{2M_2 - 1}{M_2 - 1} \right) \rceil$ | $\lceil \log_2 \left( \frac{2M_2 - 1}{M_2 - 1} \right) \rceil$ | N/A                                                            | N/A                                                            | $3(K^{NZ} - 2)$ | $4(K^{NZ} - 2)$ | $4LM_2$ |
| Rank=<br>3<br><br>$N_3 > 19$ | 4 | 4 | 4   | N/A | $\lceil \log_2(2M_3) \rceil$ | $\lceil \log_2 \left( \frac{2M_3 - 1}{M_3 - 1} \right) \rceil$ | $\lceil \log_2 \left( \frac{2M_3 - 1}{M_3 - 1} \right) \rceil$ | $\lceil \log_2 \left( \frac{2M_3 - 1}{M_3 - 1} \right) \rceil$ | N/A                                                            | $3(K^{NZ} - 3)$ | $4(K^{NZ} - 3)$ | $6LM_3$ |
| Rank=<br>4<br><br>$N_3 > 19$ | 4 | 4 | 4   | 4   | $\lceil \log_2(2M_4) \rceil$ | $\lceil \log_2 \left( \frac{2M_4 - 1}{M_4 - 1} \right) \rceil$ | $\lceil \log_2 \left( \frac{2M_4 - 1}{M_4 - 1} \right) \rceil$ | $\lceil \log_2 \left( \frac{2M_4 - 1}{M_4 - 1} \right) \rceil$ | $\lceil \log_2 \left( \frac{2M_4 - 1}{M_4 - 1} \right) \rceil$ | $3(K^{NZ} - 4)$ | $4(K^{NZ} - 4)$ | $8LM_4$ |

Note: the bitwidth for  $\{i_{1,7,l}\}_{l=1,\dots,v}$ ,  $\{i_{2,4,l}\}_{l=1,\dots,v}$  and  $\{i_{2,5,l}\}_{l=1,\dots,v}$  shown in Table 6.3.2.1.2-1A is the total bitwidth of  $\{i_{1,7,l}\}$ ,  $\{i_{2,4,l}\}$  and  $\{i_{2,5,l}\}$  up to Rank =  $v$ , respectively, and the corresponding per layer bitwidths are  $2LM_v$ ,  $3(K_l^{NZ} - 1)$ , and  $4(K_l^{NZ} - 1)$ , (i.e., 1, 3, and 4 bits for each respective indicator elements  $k_{l,i,f}^{(3)}$ ,  $k_{l,i,f}^{(2)}$ , and  $c_{l,i,f}$ , respectively), where  $K_l^{NZ}$  as defined in Clause 5.2.2.2.5 in [6, TS 38.214] is the number of nonzero coefficients for layer  $l$  such that  $K^{NZ} = \sum_{l=1}^v K_l^{NZ}$ .

The bitwidth for PMI of *codebookType= typeII-PortSelection* is provided in Tables 6.3.2.1.2-2, where the values of  $P_{CSI-RS}$ ,  $d$ ,  $L$ ,  $N_{PSK}$ ,  $M_1$ ,  $M_2$ , and  $K^{(2)}$  are given by Clause 5.2.2.2.4 in [6, TS 38.214].

**Table 6.3.2.1.2-2: PMI of *codebookType= typeII-PortSelection***

|                       | Information fields $X_1$ for wideband PMI                                        |                            |             |                            |             | Information fields $X_2$ for wideband PMI or per subband PMI                                    |                                                                                                 |                          |                          |
|-----------------------|----------------------------------------------------------------------------------|----------------------------|-------------|----------------------------|-------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|--------------------------|--------------------------|
|                       | $i_{1,1}$                                                                        | $i_{1,3,1}$                | $i_{1,4,1}$ | $i_{1,3,2}$                | $i_{1,4,2}$ | $i_{2,1,1}$                                                                                     | $i_{2,1,2}$                                                                                     | $i_{2,2,1}$              | $i_{2,2,2}$              |
| Rank=1<br>SBAm<br>off | $\left\lceil \log_2 \left\lceil \frac{P_{CSI-RS}}{2d} \right\rceil \right\rceil$ | $\lceil \log_2(2L) \rceil$ | $3(2L-1)$   | N/A                        | N/A         | $(M_1-1) \cdot \log_2 N_{PSK}$                                                                  | N/A                                                                                             | N/A                      | N/A                      |
| Rank=2<br>SBAm<br>off | $\left\lceil \log_2 \left\lceil \frac{P_{CSI-RS}}{2d} \right\rceil \right\rceil$ | $\lceil \log_2(2L) \rceil$ | $3(2L-1)$   | $\lceil \log_2(2L) \rceil$ | $3(2L-1)$   | $(M_1-1) \cdot \log_2 N_{PSK}$                                                                  | $(M_2-1) \cdot \log_2 N_{PSK}$                                                                  | N/A                      | N/A                      |
| Rank=1<br>SBAm<br>on  | $\left\lceil \log_2 \left\lceil \frac{P_{CSI-RS}}{2d} \right\rceil \right\rceil$ | $\lceil \log_2(2L) \rceil$ | $3(2L-1)$   | N/A                        | N/A         | $\min(M_1, K^{(2)}) \cdot \log_2 N_{PSK} - \log_2 N_{PSK} + 2 \cdot (M_1 - \min(M_1, K^{(2)}))$ | N/A                                                                                             | $\min(M_1, K^{(2)}) - 1$ | N/A                      |
| Rank=2<br>SBAm<br>on  | $\left\lceil \log_2 \left\lceil \frac{P_{CSI-RS}}{2d} \right\rceil \right\rceil$ | $\lceil \log_2(2L) \rceil$ | $3(2L-1)$   | $\lceil \log_2(2L) \rceil$ | $3(2L-1)$   | $\min(M_1, K^{(2)}) \cdot \log_2 N_{PSK} - \log_2 N_{PSK} + 2 \cdot (M_1 - \min(M_1, K^{(2)}))$ | $\min(M_2, K^{(2)}) \cdot \log_2 N_{PSK} - \log_2 N_{PSK} + 2 \cdot (M_2 - \min(M_2, K^{(2)}))$ | $\min(M_1, K^{(2)}) - 1$ | $\min(M_2, K^{(2)}) - 1$ |

The bitwidth for PMI of *codebookType=typeII-PortSelection-r16* is provided in Tables 6.3.2.1.2-2A, where the values of  $P_{CSI-RS}$ ,  $d$ ,  $L$ ,  $K^{NZ}$ ,  $N_3$ , and  $\{M_l\}_{l=1,\dots,v}$  are given by Clause 5.2.2.2.6 in [6, TS 38.214].

**Table 6.3.2.1.2-2A: PMI of *codebookType= typeII-PortSelection-r16***

|                             | Information fields $X_1$                                                         |                               |             |             |             |
|-----------------------------|----------------------------------------------------------------------------------|-------------------------------|-------------|-------------|-------------|
|                             | $i_{1,1}$                                                                        | $i_{1,8,1}$                   | $i_{1,8,2}$ | $i_{1,8,3}$ | $i_{1,8,4}$ |
| Rank=1<br><br>$N_3 \leq 19$ | $\left\lceil \log_2 \left\lceil \frac{P_{CSI-RS}}{2d} \right\rceil \right\rceil$ | $\lceil \log_2 K^{NZ} \rceil$ | N/A         | N/A         | N/A         |

|                         |                                                                                  |                               |                            |                            |                              |                                                         |                                                         |                                                         |                                                         |                               |                               |                               |  |
|-------------------------|----------------------------------------------------------------------------------|-------------------------------|----------------------------|----------------------------|------------------------------|---------------------------------------------------------|---------------------------------------------------------|---------------------------------------------------------|---------------------------------------------------------|-------------------------------|-------------------------------|-------------------------------|--|
| Rank=2<br>$N_3 \leq 19$ | $\left\lceil \log_2 \left\lceil \frac{P_{CSI-RS}}{2d} \right\rceil \right\rceil$ | $\lceil \log_2(2L) \rceil$    | $\lceil \log_2(2L) \rceil$ | N/A                        | N/A                          |                                                         |                                                         |                                                         |                                                         |                               |                               |                               |  |
| Rank=3<br>$N_3 \leq 19$ | $\left\lceil \log_2 \left\lceil \frac{P_{CSI-RS}}{2d} \right\rceil \right\rceil$ | $\lceil \log_2(2L) \rceil$    | $\lceil \log_2(2L) \rceil$ | $\lceil \log_2(2L) \rceil$ | N/A                          |                                                         |                                                         |                                                         |                                                         |                               |                               |                               |  |
| Rank=4<br>$N_3 \leq 19$ | $\left\lceil \log_2 \left\lceil \frac{P_{CSI-RS}}{2d} \right\rceil \right\rceil$ | $\lceil \log_2(2L) \rceil$    | $\lceil \log_2(2L) \rceil$ | $\lceil \log_2(2L) \rceil$ | $\lceil \log_2(2L) \rceil$   |                                                         |                                                         |                                                         |                                                         |                               |                               |                               |  |
| Rank=1<br>$N_3 > 19$    | $\left\lceil \log_2 \left\lceil \frac{P_{CSI-RS}}{2d} \right\rceil \right\rceil$ | $\lceil \log_2 K^{NZ} \rceil$ | N/A                        | N/A                        | N/A                          |                                                         |                                                         |                                                         |                                                         |                               |                               |                               |  |
| Rank=2<br>$N_3 > 19$    | $\left\lceil \log_2 \left\lceil \frac{P_{CSI-RS}}{2d} \right\rceil \right\rceil$ | $\lceil \log_2(2L) \rceil$    | $\lceil \log_2(2L) \rceil$ | N/A                        | N/A                          |                                                         |                                                         |                                                         |                                                         |                               |                               |                               |  |
| Rank=3<br>$N_3 > 19$    | $\left\lceil \log_2 \left\lceil \frac{P_{CSI-RS}}{2d} \right\rceil \right\rceil$ | $\lceil \log_2(2L) \rceil$    | $\lceil \log_2(2L) \rceil$ | $\lceil \log_2(2L) \rceil$ | N/A                          |                                                         |                                                         |                                                         |                                                         |                               |                               |                               |  |
| Rank=4<br>$N_3 > 19$    | $\left\lceil \log_2 \left\lceil \frac{P_{CSI-RS}}{2d} \right\rceil \right\rceil$ | $\lceil \log_2(2L) \rceil$    | $\lceil \log_2(2L) \rceil$ | $\lceil \log_2(2L) \rceil$ | $\lceil \log_2(2L) \rceil$   |                                                         |                                                         |                                                         |                                                         |                               |                               |                               |  |
|                         | Information fields $X_2$                                                         |                               |                            |                            |                              |                                                         |                                                         |                                                         |                                                         |                               |                               |                               |  |
|                         | $i_{2,3,1}$                                                                      | $i_{2,3,2}$                   | $i_{2,3,3}$                | $i_{2,3,4}$                | $i_{1,5}$                    | $i_{1,6,1}$                                             | $i_{1,6,2}$                                             | $i_{1,6,3}$                                             | $i_{1,6,4}$                                             | $\{i_{2,4,i}\}_{i=1,\dots,v}$ | $\{i_{2,5,i}\}_{i=1,\dots,v}$ | $\{i_{1,7,i}\}_{i=1,\dots,v}$ |  |
| Rank=1<br>$N_3 \leq 19$ | 4                                                                                | N/A                           | N/A                        | N/A                        | N/A                          | $\left\lceil \log_2 \binom{N_3-1}{M_1-1} \right\rceil$  | N/A                                                     | N/A                                                     | N/A                                                     | $3(K^{NZ}-1)$                 | $4(K^{NZ}-1)$                 | $2LM_1$                       |  |
| Rank=2<br>$N_3 \leq 19$ | 4                                                                                | 4                             | N/A                        | N/A                        | N/A                          | $\left\lceil \log_2 \binom{N_3-1}{M_2-1} \right\rceil$  | $\left\lceil \log_2 \binom{N_3-1}{M_2-1} \right\rceil$  | N/A                                                     | N/A                                                     | $3(K^{NZ}-2)$                 | $4(K^{NZ}-2)$                 | $4LM_2$                       |  |
| Rank=3<br>$N_3 \leq 19$ | 4                                                                                | 4                             | 4                          | N/A                        | N/A                          | $\left\lceil \log_2 \binom{N_3-1}{M_3-1} \right\rceil$  | $\left\lceil \log_2 \binom{N_3-1}{M_3-1} \right\rceil$  | $\left\lceil \log_2 \binom{N_3-1}{M_3-1} \right\rceil$  | N/A                                                     | $3(K^{NZ}-3)$                 | $4(K^{NZ}-3)$                 | $6LM_3$                       |  |
| Rank=4<br>$N_3 \leq 19$ | 4                                                                                | 4                             | 4                          | 4                          | N/A                          | $\left\lceil \log_2 \binom{N_3-1}{M_4-1} \right\rceil$  | $\left\lceil \log_2 \binom{N_3-1}{M_4-1} \right\rceil$  | $\left\lceil \log_2 \binom{N_3-1}{M_4-1} \right\rceil$  | $\left\lceil \log_2 \binom{N_3-1}{M_4-1} \right\rceil$  | $3(K^{NZ}-4)$                 | $4(K^{NZ}-4)$                 | $8LM_4$                       |  |
| Rank=1<br>$N_3 > 19$    | 4                                                                                | N/A                           | N/A                        | N/A                        | $\lceil \log_2(2M_1) \rceil$ | $\left\lceil \log_2 \binom{2M_1-1}{M_1-1} \right\rceil$ | N/A                                                     | N/A                                                     | N/A                                                     | $3(K^{NZ}-1)$                 | $4(K^{NZ}-1)$                 | $2LM_1$                       |  |
| Rank=2<br>$N_3 > 19$    | 4                                                                                | 4                             | N/A                        | N/A                        | $\lceil \log_2(2M_2) \rceil$ | $\left\lceil \log_2 \binom{2M_2-1}{M_2-1} \right\rceil$ | $\left\lceil \log_2 \binom{2M_2-1}{M_2-1} \right\rceil$ | N/A                                                     | N/A                                                     | $3(K^{NZ}-2)$                 | $4(K^{NZ}-2)$                 | $4LM_2$                       |  |
| Rank=3<br>$N_3 > 19$    | 4                                                                                | 4                             | 4                          | N/A                        | $\lceil \log_2(2M_3) \rceil$ | $\left\lceil \log_2 \binom{2M_3-1}{M_3-1} \right\rceil$ | $\left\lceil \log_2 \binom{2M_3-1}{M_3-1} \right\rceil$ | $\left\lceil \log_2 \binom{2M_3-1}{M_3-1} \right\rceil$ | N/A                                                     | $3(K^{NZ}-3)$                 | $4(K^{NZ}-3)$                 | $6LM_3$                       |  |
| Rank=4<br>$N_3 > 19$    | 4                                                                                | 4                             | 4                          | 4                          | $\lceil \log_2(2M_4) \rceil$ | $\left\lceil \log_2 \binom{2M_4-1}{M_4-1} \right\rceil$ | $\left\lceil \log_2 \binom{2M_4-1}{M_4-1} \right\rceil$ | $\left\lceil \log_2 \binom{2M_4-1}{M_4-1} \right\rceil$ | $\left\lceil \log_2 \binom{2M_4-1}{M_4-1} \right\rceil$ | $3(K^{NZ}-4)$                 | $4(K^{NZ}-4)$                 | $8LM_4$                       |  |

Note: the bitwidth for  $\{i_{1,7,l}\}_{l=1,\dots,v}$ ,  $\{i_{2,4,l}\}_{l=1,\dots,v}$  and  $\{i_{2,5,l}\}_{l=1,\dots,v}$  shown in Table 6.3.2.1.2-2A is the total bitwidth of  $\{i_{1,7,l}\}$ ,  $\{i_{2,4,l}\}$  and  $\{i_{2,5,l}\}$  up to Rank =  $v$ , respectively, and the corresponding per layer bitwidths are  $2LM_v$ ,  $3(K_l^{NZ} - 1)$ , and  $4(K_l^{NZ} - 1)$ , (i.e., 1, 3, and 4 bits for each respective indicator elements  $k_{l,i,f}^{(3)}$ ,  $k_{l,i,f}^{(2)}$ , and  $c_{l,i,f}$ , respectively), where  $K_l^{NZ}$  as defined in Clause 5.2.2.2.5 in [6, TS 38.214] is the number of nonzero coefficients for layer  $l$  such that  $K^{NZ} = \sum_{l=1}^v K_l^{NZ}$ .

The bitwidth for PMI of *codebookType=typeII-PortSelection-r17* is provided in Tables 6.3.2.1.2-2B, where the values of  $P_{CSI-RS}$ ,  $K_1$ ,  $K^{NZ}$ ,  $N_3$ ,  $N$  and  $M$  are given by Clause 5.2.2.2.7 in [6, TS 38.214].

**Table 6.3.2.1.2-2B: PMI of *codebookType= typeII-PortSelection-r17***

|        | Information fields $X_1$                                                  |                                                          |                              |                              |                               |                               |                                              |
|--------|---------------------------------------------------------------------------|----------------------------------------------------------|------------------------------|------------------------------|-------------------------------|-------------------------------|----------------------------------------------|
|        | $i_{1,2}$                                                                 | $i_{1,6}$                                                | $i_{1,8,1}$                  | $i_{1,8,2}$                  | $i_{1,8,3}$                   | $i_{1,8,4}$                   |                                              |
| Rank=1 | $\left\lceil \log_2 \left( \frac{P_{CSI-RS}}{K_1/2} \right) \right\rceil$ | $\lceil \log_2(N-1) \rceil$ if $N > M=2$ , N/A otherwise | $\lceil \log_2(K_1M) \rceil$ | N/A                          | N/A                           | N/A                           |                                              |
| Rank=2 | $\left\lceil \log_2 \left( \frac{P_{CSI-RS}}{K_1/2} \right) \right\rceil$ | $\lceil \log_2(N-1) \rceil$ if $N > M=2$ , N/A otherwise | $\lceil \log_2(K_1M) \rceil$ | $\lceil \log_2(K_1M) \rceil$ | N/A                           | N/A                           |                                              |
| Rank=3 | $\left\lceil \log_2 \left( \frac{P_{CSI-RS}}{K_1/2} \right) \right\rceil$ | $\lceil \log_2(N-1) \rceil$ if $N > M=2$ , N/A otherwise | $\lceil \log_2(K_1M) \rceil$ | $\lceil \log_2(K_1M) \rceil$ | $\lceil \log_2(K_1M) \rceil$  | N/A                           |                                              |
| Rank=4 | $\left\lceil \log_2 \left( \frac{P_{CSI-RS}}{K_1/2} \right) \right\rceil$ | $\lceil \log_2(N-1) \rceil$ if $N > M=2$ , N/A otherwise | $\lceil \log_2(K_1M) \rceil$ | $\lceil \log_2(K_1M) \rceil$ | $\lceil \log_2(K_1M) \rceil$  | $\lceil \log_2(K_1M) \rceil$  |                                              |
|        | Information fields $X_2$                                                  |                                                          |                              |                              |                               |                               |                                              |
|        | $i_{2,3,1}$                                                               | $i_{2,3,2}$                                              | $i_{2,3,3}$                  | $i_{2,3,4}$                  | $\{i_{2,4,l}\}_{l=1,\dots,v}$ | $\{i_{2,5,l}\}_{l=1,\dots,v}$ | $\{i_{1,7,l}\}_{l=1,\dots,v}$                |
| Rank=1 | 4                                                                         | N/A                                                      | N/A                          | N/A                          | $3(K^{NZ}-1)$                 | $4(K^{NZ}-1)$                 | N/A if $K^{NZ}=K_1M$ ;<br>$K_1M$ otherwise   |
| Rank=2 | 4                                                                         | 4                                                        | N/A                          | N/A                          | $3(K^{NZ}-2)$                 | $4(K^{NZ}-2)$                 | N/A if $K^{NZ}=2K_1M$ ;<br>$2K_1M$ otherwise |
| Rank=3 | 4                                                                         | 4                                                        | 4                            | N/A                          | $3(K^{NZ}-3)$                 | $4(K^{NZ}-3)$                 | $3K_1M$                                      |
| Rank=4 | 4                                                                         | 4                                                        | 4                            | 4                            | $3(K^{NZ}-4)$                 | $4(K^{NZ}-4)$                 | $4K_1M$                                      |

Note: the bitwidth for  $\{i_{1,7,l}\}_{l=1,\dots,v}$ ,  $\{i_{2,4,l}\}_{l=1,\dots,v}$  and  $\{i_{2,5,l}\}_{l=1,\dots,v}$  shown in Table 6.3.2.1.2-2B is the total bitwidth of  $\{i_{1,7,l}\}$ ,  $\{i_{2,4,l}\}$  and  $\{i_{2,5,l}\}$  up to Rank =  $v$ , respectively, and the corresponding per layer bitwidths are  $K_1 M$ ,  $3(K_l^{NZ} - 1)$ , and  $4(K_l^{NZ} - 1)$ , (i.e., 1, 3, and 4 bits for each respective indicator elements  $k_{l,i,f}^{(3)}$ ,  $k_{l,i,f}^{(2)}$ , and  $c_{l,i,f}$ , respectively), where  $K_l^{NZ}$  as defined in Clause 5.2.2.2.7 in [6, TS 38.214] is the number of nonzero coefficients for layer  $l$  such that  $K^{NZ} = \sum_{l=1}^v K_l^{NZ}$ .

For CSI on PUSCH, two UCI bit sequences are generated,  $a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{A^{(1)}-1}^{(1)}$  and  $a_0^{(2)}, a_1^{(2)}, a_2^{(2)}, a_3^{(2)}, \dots, a_{A^{(2)}-1}^{(2)}$ . The CSI fields of all CSI reports, in the order from upper part to lower part in Table 6.3.2.1.2-6, are mapped to the UCI bit sequence  $a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{A^{(1)}-1}^{(1)}$  starting with  $a_0^{(1)}$ . The CSI fields of all CSI reports, in the order from upper part to lower part in Table 6.3.2.1.2-7, are mapped to the UCI bit sequence  $a_0^{(2)}, a_1^{(2)}, a_2^{(2)}, a_3^{(2)}, \dots, a_{A^{(2)}-1}^{(2)}$  starting with  $a_0^{(2)}$ .

The mapping order of CSI fields of one report for CRI/RSRP or SSBRI/RSRP or CRI/RSRP/CapabilityIndex or SSBRI/RSRP/CapabilityIndex reporting is provided in Table 6.3.1.1.2-8. The mapping order of CSI fields of one report for inter-cell SSBRI/RSRP reporting is provided in Table 6.3.1.1.2-8. The mapping order of CSI fields of one report for CRI/SINR or SSBRI/SINR or CRI/SINR/CapabilityIndex or SSBRI/SINR/CapabilityIndex reporting is provided in Table 6.3.1.1.2-8A. The mapping order of CSI fields of one report for group-based CRI/RSRP or SSBRI/RSRP reporting is provided in Table 6.3.1.1.2-8B. The procedure in clause 6.3.2 described for CSI part 1 is also applicable for one report for CRI/RSRP, SSBRI/RSRP, CRI/SINR, or SSBRI/SINR reporting.

**Table 6.3.2.1.2-3: Mapping order of CSI fields of one CSI report, CSI part 1**

| CSI report number           | CSI fields                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report #n<br>CSI part 1 | CRI as in Tables 6.3.1.1.2-3/4/6, if reported                                                                                                                                                                                                                                                                                                     |
|                             | Rank Indicator as in Tables 6.3.1.1.2-3/4/5 or 6.3.2.1.2-8/9, if reported                                                                                                                                                                                                                                                                         |
|                             | Wideband CQI for the first TB as in Tables 6.3.1.1.2-3/4/5 or 6.3.2.1.2-8/9, if reported                                                                                                                                                                                                                                                          |
|                             | Subband differential CQI for the first TB with increasing order of subband number as in Tables 6.3.1.1.2-3/4/5 or 6.3.2.1.2-8/9, if reported                                                                                                                                                                                                      |
|                             | Indicator of the number of non-zero wideband amplitude coefficients $M_0$ for layer 0 as in Table 6.3.1.1.2-5, if reported                                                                                                                                                                                                                        |
|                             | Indicator of the number of non-zero wideband amplitude coefficients $M_1$ for layer 1 as in Table 6.3.1.1.2-5 (if the rank according to the reported RI is equal to one, this field is set to all zeros), if 2-layer PMI reporting is allowed according to the rank restriction in Clauses 5.2.2.2.3 and 5.2.2.2.4 [6, TS 38.214] and if reported |
|                             | Indicator of the total number of non-zero coefficients summed across all layers $K^{NZ}$ as in Table 6.3.2.1.2-8/9, if reported                                                                                                                                                                                                                   |
| Note:                       | Subbands for given CSI report $n$ indicated by the higher layer parameter <i>csi-ReportingBand</i> are numbered continuously in the increasing order with the lowest subband of <i>csi-ReportingBand</i> as subband 0.                                                                                                                            |

**Table 6.3.2.1.2-3A: Mapping order of CSI fields of one CSI report, CSI part 1, *csi-ReportMode*= *Mode 1***

| CSI report number                   | CSI fields                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report # <i>n</i><br>CSI part 1 | CRI as in Tables 6.3.1.1.2-3A, if associated with one CSI-RS resource pair and if reported                                                                                                                                                                                                                                                                                                      |
|                                     | Rank Combination Indicator as in Tables 6.3.1.1.2-3A, if reported                                                                                                                                                                                                                                                                                                                               |
|                                     | Wideband CQI for the first TB as in Tables 6.3.1.1.2-3A, if reported                                                                                                                                                                                                                                                                                                                            |
|                                     | Subband differential CQI for the first TB with increasing order of subband number as in Tables 6.3.1.1.2-3A, if reported                                                                                                                                                                                                                                                                        |
|                                     | CRI as in Tables 6.3.1.1.2-3B, if associated with one CSI-RS resource, <i>numberOfSingleTRP-CSI-Mode1</i> = 1 and if reported;<br>First CRI as in Tables 6.3.1.1.2-3B, if associated with one CSI-RS resource, <i>numberOfSingleTRP-CSI-Mode1</i> = 2 and if reported                                                                                                                           |
|                                     | Rank Indicator associated with CRI as in Tables 6.3.1.1.2-3B, if <i>numberOfSingleTRP-CSI-Mode1</i> = 1 and if reported;<br>Rank Indicator associated with the first CRI as in Tables 6.3.1.1.2-3B, if <i>numberOfSingleTRP-CSI-Mode1</i> = 2 and if reported                                                                                                                                   |
|                                     | Wideband CQI associated with CRI for the first TB as in Tables 6.3.1.1.2-3B, if <i>numberOfSingleTRP-CSI-Mode1</i> = 1 and if reported;<br>Wideband CQI associated with the first CRI for the first TB as in Tables 6.3.1.1.2-3B, if <i>numberOfSingleTRP-CSI-Mode1</i> = 2 and if reported                                                                                                     |
|                                     | Subband differential CQI associated with CRI for the first TB with increasing order of subband number as in Tables 6.3.1.1.2-3B, if <i>numberOfSingleTRP-CSI-Mode1</i> = 1 if reported;<br>Subband differential CQI associated with the first CRI for the first TB with increasing order of subband number as in Tables 6.3.1.1.2-3B, if <i>numberOfSingleTRP-CSI-Mode1</i> = 2 and if reported |
|                                     | Second CRI as in Tables 6.3.1.1.2-3B, if associated with one CSI-RS resource, <i>numberOfSingleTRP-CSI-Mode1</i> = 2 and if reported                                                                                                                                                                                                                                                            |
|                                     | Rank Indicator associated with the second CRI as in Tables 6.3.1.1.2-3B, if <i>numberOfSingleTRP-CSI-Mode1</i> = 2 and if reported                                                                                                                                                                                                                                                              |
|                                     | Wideband CQI associated with the second CRI for the first TB as in Tables 6.3.1.1.2-3B, if <i>numberOfSingleTRP-CSI-Mode1</i> = 2 and if reported                                                                                                                                                                                                                                               |
|                                     | Subband differential CQI associated with the second CRI for the first TB with increasing order of subband number as in Tables 6.3.1.1.2-3B, if <i>numberOfSingleTRP-CSI-Mode1</i> = 2 and if reported                                                                                                                                                                                           |
| Note:                               | Subbands for given CSI report <i>n</i> indicated by the higher layer parameter <i>csi-ReportingBand</i> are numbered continuously in the increasing order with the lowest subband of <i>csi-ReportingBand</i> as subband 0.                                                                                                                                                                     |

**Table 6.3.2.1.2-3B: Mapping order of CSI fields of one CSI report, CSI part 1, *csi-ReportMode*= *Mode 2***

| CSI report number                   | CSI fields                                                                                                                                                                                                                                                                                                                                       |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report # <i>n</i><br>CSI part 1 | CRI as in Tables 6.3.1.1.2-3A, if associated with one CSI-RS resource pair and if reported;<br>CRI as in Tables 6.3.1.1.2-3B, if associated with one CSI-RS resource and if reported                                                                                                                                                             |
|                                     | Rank Combination Indicator as in Tables 6.3.1.1.2-3A, if associated with one CSI-RS resource pair and if reported;<br>Rank Indicator as in Tables 6.3.1.1.2-3B, if associated with one CSI-RS resource and if reported;<br>Zero padding bits $O_p$ , if needed                                                                                   |
|                                     | Wideband CQI for the first TB as in Tables 6.3.1.1.2-3A, if associated with one CSI-RS resource pair and if reported;<br>Wideband CQI for the first TB as in Tables 6.3.1.1.2-3B, if associated with one CSI-RS resource and if reported                                                                                                         |
|                                     | Subband differential CQI for the first TB with increasing order of subband number as in Tables 6.3.1.1.2-3A, if associated with one CSI-RS resource pair and if reported;<br>Subband differential CQI for the first TB with increasing order of subband number as in Tables 6.3.1.1.2-3B, if associated with one CSI-RS resource and if reported |
|                                     |                                                                                                                                                                                                                                                                                                                                                  |
| Note:                               | Subbands for given CSI report <i>n</i> indicated by the higher layer parameter <i>csi-ReportingBand</i> are numbered continuously in the increasing order with the lowest subband of <i>csi-ReportingBand</i> as subband 0.                                                                                                                      |



The number of zero padding bits  $O_p$  in Table 6.3.2.1.2-3B is 0 for 1 CSI-RS port and  $O_p = N_{\max} - N_{\text{reported}}(R)$  for more than 1 CSI-RS port, where

- $N_{\max} = \max_{r \in S_{\text{Rank}}} N(r) \cdot S_{\text{Rank}}$  is the set of rank and rank combination values  $r$  that are allowed to be reported.  $N(r)$  is obtained according to Tables 6.3.1.1.2-3A/3B for rank combination indicator and rank indicator respectively.
- $N_{\text{reported}}(R)$  is obtained according to Tables 6.3.1.1.2-3A for rank combination indicator and  $R$  is the reported rank combination
- $N_{\text{reported}}(R)$  is obtained according to Tables 6.3.1.1.2-3B for rank indicator and  $R$  is the reported rank

**Table 6.3.2.1.2-4: Mapping order of CSI fields of one CSI report, CSI part 2 wideband**

| CSI report number                       | CSI fields                                                                                                                                                                                                                                                       |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report #n<br>CSI part 2<br>wideband | Wideband CQI for the second TB as in Tables 6.3.1.1.2-3/4/5, if present and reported                                                                                                                                                                             |
|                                         | Layer Indicator as in Tables 6.3.1.1.2-3/4/5, if reported                                                                                                                                                                                                        |
|                                         | PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1/2 or 6.3.2.1.2-1/2, if reported                                                                                                                                              |
|                                         | PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1/2 or 6.3.2.1.2-1/2, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214], if <i>pmi-FormatIndicator</i> = <i>widebandPMI</i> and if reported |

**Table 6.3.2.1.2-4A: Mapping order of CSI fields of one CSI report, CSI part 2 wideband, *csi-ReportMode= Mode 1***

| CSI report number                       | CSI fields                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report #n<br>CSI part 2<br>wideband | Two Layer Indicators as in Table 6.3.1.1.2-3A, where the first Layer Indicator and the second Layer Indicator are associated with the first resource and the second resource within the resource pair respectively and if reported;                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                         | PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1 associated with the first resource within the CSI-RS resource pair, if reported                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                         | PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214] associated with the first CSI-RS resource within the CSI-RS resource pair, if <i>pmi-FormatIndicator= widebandPMI</i> and if reported                                                                                                                                                                                                                                                                                                                                   |
|                                         | PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1 associated with the second resource within the CSI-RS resource pair, if reported                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                                         | PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214] associated with the second CSI-RS resource within the CSI-RS resource pair, if <i>pmi-FormatIndicator= widebandPMI</i> and if reported                                                                                                                                                                                                                                                                                                                                  |
|                                         | Wideband CQI for the second TB as in Tables 6.3.1.1.2-3B, if associated with CRI in CSI part 1, <i>numberOfSingleTRP-CSI-Mode1 = 1</i> and if reported;<br>Wideband CQI for the second TB as in Tables 6.3.1.1.2-3B, if associated with the first CRI in CSI part 1, <i>numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                       |
|                                         | Layer Indicator as in Table 6.3.1.1.2-3B, if associated with CRI in CSI part 1, <i>numberOfSingleTRP-CSI-Mode1 = 1</i> and if reported;<br>Layer Indicator as in Table 6.3.1.1.2-3B, if associated with the first CRI in CSI part 1, <i>numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                                                       |
|                                         | PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1, if associated with CRI in CSI part 1, <i>numberOfSingleTRP-CSI-Mode1 = 1</i> and if reported;<br>PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1, if associated with the first CRI in CSI part 1, <i>numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                 |
|                                         | PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214], if associated with CRI in CSI part 1, <i>pmi-FormatIndicator= widebandPMI</i> , <i>numberOfSingleTRP-CSI-Mode1 = 1</i> and if reported;<br>PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214], if associated with the first CRI in CSI part 1, <i>pmi-FormatIndicator= widebandPMI</i> , <i>numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported |
|                                         | Wideband CQI for the second TB as in Tables 6.3.1.1.2-3B, if associated with the second CRI in CSI part 1, <i>numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|                                         | Layer Indicator as in Table 6.3.1.1.2-3B, if associated with the second CRI in CSI part 1, <i>numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|                                         | PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1, if associated with the second CRI in CSI part 1, <i>numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                                         | PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214], if associated with the second CRI in CSI part 1, <i>pmi-FormatIndicator= widebandPMI</i> , <i>numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                      |

**Table 6.3.2.1.2-4B: Mapping order of CSI fields of one CSI report, CSI part 2 wideband, *csi-ReportMode= Mode 2***

| CSI report number                       | CSI fields                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report #n<br>CSI part 2<br>wideband | Wideband CQI for the second TB as in Tables 6.3.1.1.2-3B, if reported part 1 is associated with one CSI-RS resource and if reported                                                                                                                                                                                                                                                                                        |
|                                         | Two Layer Indicators as in Table 6.3.1.1.2-3A, if reported part 1 is associated with one CSI-RS resource pair, where the first Layer Indicator and the second Layer Indicator are associated with the first resource and the second resource within the resource pair respectively and if reported;<br>Layer Indicator as in Table 6.3.1.1.2-3B, if reported part 1 is associated with one CSI-RS resource and if reported |
|                                         | PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1 associated with the first resource within the CSI-RS resource pair, if reported part 1 is associated with one CSI-RS resource pair and if reported                                                                                                                                                                                     |
|                                         | PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214] associated with the first CSI-RS resource within the CSI-RS resource pair, if <i>pmi-FormatIndicator= widebandPMI</i> and reported part 1 is associated with one CSI-RS resource pair and if reported                                            |
|                                         | PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1 associated with the second CSI-RS resource within the CSI-RS resource pair, if reported part 1 is associated with one CSI-RS resource pair and if reported                                                                                                                                                                             |
|                                         | PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214] associated with the second CSI-RS resource within the CSI-RS resource pair, if <i>pmi-FormatIndicator= widebandPMI</i> and reported part 1 is associated with one CSI-RS resource pair and if reported                                           |
|                                         | PMI wideband information fields $X_1$ , from left to right as in Tables 6.3.1.1.2-1, if reported part 1 is associated with one CSI-RS resource and if reported                                                                                                                                                                                                                                                             |
|                                         | PMI wideband information fields $X_2$ , from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214], if <i>pmi-FormatIndicator= widebandPMI</i> and reported part 1 is associated with one CSI-RS resource and if reported                                                                                                                           |

**Table 6.3.2.1.2-5: Mapping order of CSI fields of one CSI report, CSI part 2 subband**

|                                 |                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report #n<br>Part 2 subband | Subband differential CQI for the second TB of all even subbands with increasing order of subband number, as in Tables 6.3.1.1.2-3/4/5, if <i>cqi-FormatIndicator=subbandCQI</i> and if reported                                                                                                                                                                                 |
|                                 | PMI subband information fields $X_2$ of all even subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1/2 or 6.3.2.1.2-1/2, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214] of all even subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI</i> and if reported |
|                                 | Subband differential CQI for the second TB of all odd subbands with increasing order of subband number, as in Tables 6.3.1.1.2-3/4/5, if <i>cqi-FormatIndicator=subbandCQI</i> and if reported                                                                                                                                                                                  |
|                                 | PMI subband information fields $X_2$ of all odd subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1/2 or 6.3.2.1.2-1/2, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214] of all odd subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI</i> and if reported   |

Note: Subbands for given CSI report *n* indicated by the higher layer parameter *csi-ReportingBand* are numbered continuously in the increasing order with the lowest subband of *csi-ReportingBand* as subband 0.

**Table 6.3.2.1.2-5A: Mapping order of CSI fields of one CSI report, CSI part 2 of *codebookType=typell-r16* or *typell-PortSelection-r16***

| CSI report number                    | CSI fields                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report #n<br>CSI part 2, group 0 | PMI fields $X_1$ , from left to right as in Tables 6.3.2.1.2-1A/2A, if reported                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| CSI report #n<br>CSI part 2, group 1 | The following PMI fields $X_2$ , from left to right, as in Tables 6.3.2.1.2-1A/2A: $\{i_{2,3,l}: l = 1, \dots, v\}$ , $i_{1,5}$ , $\{i_{1,6,l}: l = 1, \dots, v\}$ and $\max(0, \lfloor \frac{K^{NZ}}{2} \rfloor - v) \times 3$ highest priority bits of $\{i_{2,4,l}: l = 1, \dots, v\}$ , $\max(0, \lfloor \frac{K^{NZ}}{2} \rfloor - v) \times 4$ highest priority bits of $\{i_{2,5,l}: l = 1, \dots, v\}$ and $v * 2LM_v - \lfloor K^{NZ}/2 \rfloor$ highest priority bits of $\{i_{1,7,l}: l = 1, \dots, v\}$ , in decreasing order of priority based on the corresponding function $\text{Pri}(l, i, f)$ defined in clause 5.2.3 of TS38.214, if reported |
| CSI report #n<br>CSI part 2, group 2 | The following PMI fields $X_2$ , from left to right, as in Tables 6.3.2.1.2-1A/2A: $\min(K^{NZ} - v, \lfloor \frac{K^{NZ}}{2} \rfloor) \times 3$ lowest priority bits of $\{i_{2,4,l}: l = 1, \dots, v\}$ , $\min(K^{NZ} - v, \lfloor \frac{K^{NZ}}{2} \rfloor) \times 4$ lowest priority bits of $\{i_{2,5,l}: l = 1, \dots, v\}$ and $\lfloor K^{NZ}/2 \rfloor$ lowest priority bits of $\{i_{1,7,l}: l = 1, \dots, v\}$ , in decreasing order of priority based on the corresponding function $\text{Pri}(l, i, f)$ defined in clause 5.2.3 of TS38.214, if reported                                                                                          |

**Table 6.3.2.1.2-5B: Mapping order of CSI fields of one CSI report, CSI part 2 of *codebookType=typell-PortSelection-r17***

| CSI report number                    | CSI fields                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report #n<br>CSI part 2, group 0 | PMI fields $X_1$ , from left to right as in Tables 6.3.2.1.2-2B, if reported                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| CSI report #n<br>CSI part 2, group 1 | The following PMI fields $X_2$ , from left to right, as in Tables 6.3.2.1.2-2B: $\{i_{2,3,l}: l = 1, \dots, v\}$ $(\max(0, \lfloor \frac{K^{NZ}}{2} \rfloor - v) \times 3$ highest priority bits of $\{i_{2,4,l}: l = 1, \dots, v\}$ , $(\max(0, \lfloor \frac{K^{NZ}}{2} \rfloor - v) \times 4$ highest priority bits of $\{i_{2,5,l}: l = 1, \dots, v\}$ and $v * K_1M - \lfloor K^{NZ}/2 \rfloor$ highest priority bits of $\{i_{1,7,l}: l = 1, \dots, v\}$ , in decreasing order of priority based on the corresponding function $\text{Pri}(l, i, f)$ defined in clause 5.2.3 of TS38.214, if reported |
| CSI report #n<br>CSI part 2, group 2 | The following PMI fields $X_2$ , from left to right, as in Tables 6.3.2.1.2-2B: $(\min(K^{NZ} - v, \lfloor \frac{K^{NZ}}{2} \rfloor) \times 3$ lowest priority bits of $\{i_{2,4,l}: l = 1, \dots, v\}$ , $(\min(K^{NZ} - v, \lfloor \frac{K^{NZ}}{2} \rfloor) \times 4$ lowest priority bits of $\{i_{2,5,l}: l = 1, \dots, v\}$ and $\lfloor K^{NZ}/2 \rfloor$ lowest priority bits of $\{i_{1,7,l}: l = 1, \dots, v\}$ , in decreasing order of priority based on the corresponding function $\text{Pri}(l, i, f)$ defined in clause 5.2.3 of TS38.214, if reported                                      |

**Table 6.3.2.1.2-5C: Mapping order of CSI fields of one CSI report, CSI part 2 subband, *ReportMode=Mode 1***

|                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report #n<br>Part 2 subband | PMI subband information fields $X_2$ of all even subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the first resource within the CSI-RS resource pair, according to Clause 5.2.2.2.1 in [6, TS38.214] of all even subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI</i> and if reported  |
|                                 | PMI subband information fields $X_2$ of all even subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the second resource within the CSI-RS resource pair, according to Clause 5.2.2.2.1 in [6, TS38.214] of all even subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI</i> and if reported |
|                                 | Subband differential CQI for the second TB of all even subbands with increasing order of subband number associated with CRI in CSI part 1, as in Tables 6.3.1.1.2-3B, if <i>cqi-FormatIndicator=subbandCQI</i> , <i>numberOfSingleTRP-CSI-Mode1 = 1</i> and if reported;                                                                                                                                                          |

|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | Subband differential CQI for the second TB of all even subbands with increasing order of subband number associated with the first CRI in CSI part 1, as in Tables 6.3.1.1.2-3B, if <i>cqi-FormatIndicator=subbandCQI, numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|  | PMI subband information fields $X_2$ of all even subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with CRI in CSI part 1 according to Clause 5.2.2.2.1 in [6, TS38.214] of all even subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI, numberOfSingleTRP-CSI-Mode1 = 1</i> and if reported;<br><br>PMI subband information fields $X_2$ of all even subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the first CRI in CSI part 1 according to Clause 5.2.2.2.1 in [6, TS38.214] of all even subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI, numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported |
|  | Subband differential CQI for the second TB of all even subbands with increasing order of subband number associated with the second CRI in CSI part 1, as in Tables 6.3.1.1.2-3B, if <i>cqi-FormatIndicator=subbandCQI, numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|  | PMI subband information fields $X_2$ of all even subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the second CRI in CSI part 1 according to Clause 5.2.2.2.1 in [6, TS38.214] of all even subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI, numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|  | PMI subband information fields $X_2$ of all odd subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the first resource within the CSI-RS resource pair, according to Clause 5.2.2.2.1 in [6, TS38.214] of all odd subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI</i> and if reported                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|  | PMI subband information fields $X_2$ of all odd subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the second resource within the CSI-RS resource pair, according to Clause 5.2.2.2.1 in [6, TS38.214] of all odd subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI</i> and if reported                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|  | Subband differential CQI for the second TB of all odd subbands with increasing order of subband number associated with CRI in CSI part 1, as in Tables 6.3.1.1.2-3B, if <i>cqi-FormatIndicator=subbandCQI, numberOfSingleTRP-CSI-Mode1 = 1</i> and if reported;<br>Subband differential CQI for the second TB of all odd subbands with increasing order of subband number associated with the first CRI in CSI part 1, as in Tables 6.3.1.1.2-3B, if <i>cqi-FormatIndicator=subbandCQI, numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                                       |
|  | PMI subband information fields $X_2$ of all odd subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with CRI in CSI part 1 according to Clause 5.2.2.2.1 in [6, TS38.214] of all odd subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI, numberOfSingleTRP-CSI-Mode1 = 1</i> and if reported;<br><br>PMI subband information fields $X_2$ of all odd subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the first CRI in CSI part 1 according to Clause 5.2.2.2.1 in [6, TS38.214] of all odd subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI, numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported     |
|  | Subband differential CQI for the second TB of all odd subbands with increasing order of subband number associated with the second CRI in CSI part 1, as in Tables 6.3.1.1.2-3B, if <i>cqi-FormatIndicator=subbandCQI, numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|  | PMI subband information fields $X_2$ of all odd subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the second CRI in CSI part 1 according to Clause 5.2.2.2.1 in [6, TS38.214] of all odd subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI, numberOfSingleTRP-CSI-Mode1 = 2</i> and if reported                                                                                                                                                                                                                                                                                                                                                                                                                                          |

**Table 6.3.2.1.2-5D: Mapping order of CSI fields of one CSI report, CSI part 2 subband, *ReportMode=Mode 2***

|                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CSI report #n<br>Part 2 subband | PMI subband information fields $X_2$ of all even subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the first resource within the CSI-RS resource pair, according to Clause 5.2.2.2.1 in [6, TS38.214] of all even subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI</i> and reported part 1 is associated with one CSI-RS resource pair and if reported  |
|                                 | PMI subband information fields $X_2$ of all even subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the second resource within the CSI-RS resource pair, according to Clause 5.2.2.2.1 in [6, TS38.214] of all even subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI</i> and reported part 1 is associated with one CSI-RS resource pair and if reported |
|                                 | PMI subband information fields $X_2$ of all odd subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the first resource within the CSI-RS resource pair, according to Clause 5.2.2.2.1 in [6, TS38.214] of all odd subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI</i> and reported part 1 is associated with one CSI-RS resource pair and if reported    |
|                                 | PMI subband information fields $X_2$ of all odd subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with the second resource within the CSI-RS resource pair, according to Clause 5.2.2.2.1 in [6, TS38.214] of all odd subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI</i> and reported part 1 is associated with one CSI-RS resource pair and if reported   |
|                                 | Subband differential CQI for the second TB of all even subbands with increasing order of subband number associated with one CSI-RS resource, as in Tables 6.3.1.1.2-3B, if <i>cqi-FormatIndicator=subbandCQI</i> and reported part 1 is associated with one CSI-RS resource and if reported                                                                                                                                                                                                       |
|                                 | PMI subband information fields $X_2$ of all even subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1, or codebook index for 2 antenna ports associated with one CSI-RS resource according to Clause 5.2.2.2.1 in [6, TS38.214] of all even subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI</i> and reported part 1 is associated with one CSI-RS resource and if reported                                       |
|                                 | Subband differential CQI for the second TB of all odd subbands with increasing order of subband number associated with one CSI-RS resource, as in Tables 6.3.1.1.2-3B, if <i>cqi-FormatIndicator=subbandCQI</i> and reported part 1 is associated with one CSI-RS resource and if reported                                                                                                                                                                                                        |
|                                 | PMI subband information fields $X_2$ of all odd subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1/2, or codebook index for 2 antenna ports associated with one CSI-RS resource according to Clause 5.2.2.2.1 in [6, TS38.214] of all odd subbands with increasing order of subband number, if <i>pmi-FormatIndicator= subbandPMI</i> and reported part 1 is associated with one CSI-RS resource and if reported                                       |

**Table 6.3.2.1.2-6: Mapping order of CSI reports to UCI bit sequence  $a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{A^{(1)}-1}^{(1)}$ , with two-part CSI report(s)**

| UCI bit sequence      | CSI report number                                                                    |
|-----------------------|--------------------------------------------------------------------------------------|
| $a_0^{(1)}$           | CSI part 1 of CSI report #1 as in Table 6.3.2.1.2-3/3A/3B or Table 6.3.1.1.2-8/8A/8B |
| $a_1^{(1)}$           | CSI part 1 of CSI report #2 as in Table 6.3.2.1.2-3/3A/3B or Table 6.3.1.1.2-8/8A/8B |
| $a_2^{(1)}$           |                                                                                      |
| $a_3^{(1)}$           | ...                                                                                  |
| $\vdots$              |                                                                                      |
| $a_{A^{(1)}-1}^{(1)}$ | CSI part 1 of CSI report #n as in Table 6.3.2.1.2-3/3A/3B or Table 6.3.1.1.2-8/8A/8B |

where CSI report #1, CSI report #2, ..., CSI report #n in Table 6.3.2.1.2-6 correspond to the CSI reports in increasing order of CSI report priority values according to Clause 5.2.5 of [6, TS38.214].

**Table 6.3.2.1.2-7: Mapping order of CSI reports to UCI bit sequence  $a_0^{(2)}, a_1^{(2)}, a_2^{(2)}, a_3^{(2)}, \dots, a_{A^{(2)}-1}^{(2)}$ , with two-part CSI report(s)**

| UCI bit sequence                                                                              | CSI report number                                                                                                                                                             |
|-----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $a_0^{(2)}$<br>$a_1^{(2)}$<br>$a_2^{(2)}$<br>$a_3^{(2)}$<br>$\vdots$<br>$a_{A^{(2)}-1}^{(2)}$ | CSI report #1, CSI part 2 wideband, as in Table 6.3.2.1.2-4/4A/4B,<br>or CSI part 2 with group 0, as in Table 6.3.2.1.2-5A/5B,<br>if CSI part 2 exists for CSI report #1      |
|                                                                                               | CSI report #2, CSI part 2 wideband, as in Table 6.3.2.1.2-4/4A/4B,<br>or CSI part 2 with group 0, as in Table 6.3.2.1.2-5A/5B,<br>if CSI part 2 exists for CSI report #2      |
|                                                                                               | ...                                                                                                                                                                           |
|                                                                                               | CSI report #n, CSI part 2 wideband, as in Table 6.3.2.1.2-4/4A/4B,<br>or CSI part 2 with group 0, as in Table 6.3.2.1.2-5A/5B,<br>if CSI part 2 exists for CSI report #n      |
|                                                                                               | CSI report #1, CSI part 2 subband, as in Table 6.3.2.1.2-5/5C/5D,<br>or CSI part 2 with group 1 and 2, as in Table 6.3.2.1.2-5A/5B,<br>if CSI part 2 exists for CSI report #1 |
|                                                                                               | CSI report #2, CSI part 2 subband, as in Table 6.3.2.1.2-5/5C/5D,<br>or CSI part 2 with group 1 and 2, as in Table 6.3.2.1.2-5A/5B,<br>if CSI part 2 exists for CSI report #2 |
|                                                                                               | ...                                                                                                                                                                           |
|                                                                                               | CSI report #n, CSI part 2 subband, as in Table 6.3.2.1.2-5/5C/5D,<br>or CSI part 2 with group 1 and 2, as in Table 6.3.2.1.2-5A/5B,<br>if CSI part 2 exists for CSI report #n |

where CSI report #1, CSI report #2, ..., CSI report #n in Table 6.3.2.1.2-7 correspond to the CSI reports in increasing order of CSI report priority values according to Clause 5.2.5 of [6, TS38.214].

The bitwidth for RI/CQI of *codebookType*= *typeII-r16* or *codebookType*=*typeII-PortSelection-r16* is provided in Table 6.3.2.1.2-8.

**Table 6.3.2.1.2-8: RI and CQI of *codebookType=typeII-r16* or *typeII-PortSelection-r16***

| Field                                                                                    | Bitwidth                                                                                        |
|------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| Rank Indicator                                                                           | $\min(2, \lceil \log_2 n_{RI} \rceil)$                                                          |
| Wide-band CQI                                                                            | 4                                                                                               |
| Subband differential CQI                                                                 | 2                                                                                               |
| Indicator of the total number of non-zero coefficients summed across all layers $K^{NZ}$ | $\lceil \log_2(K_0) \rceil$ if max allowed rank is 1;<br>$\lceil \log_2(2K_0) \rceil$ otherwise |

where  $n_{RI}$  is the number of allowed rank indicator values according to Clauses 5.2.2.2.5 and 5.2.2.2.6 [6, TS 38.214],  $K_0 = \left\lceil 2L \left[ p_1 \times \frac{N_3}{R} \right] \beta \right\rceil$ , where  $p_1$ ,  $N_3$ ,  $R$ , and  $\beta$  are given by Clause 5.2.2.2.5 and 5.2.2.2.6 in [6, TS 38.214]. The values of the rank indicator field are mapped to allowed rank indicator values with increasing order, where '0' is mapped to the smallest allowed rank indicator value. The values of the  $K^{NZ}$  indicator field are mapped to the allowed values of  $K^{NZ}$ , according to Clauses 5.2.2.2.5 and 5.2.2.2.6 [6, TS 38.214], with increasing order, where '0' is mapped to  $K^{NZ} = 1$ .

The bitwidth for RI/CQI of *codebookType=typeII-PortSelection-r17* is provided in Table 6.3.2.1.2-9.

**Table 6.3.2.1.2-9: RI and CQI of *codebookType=typeII-PortSelection-r17***

| Field                                                                                    | Bitwidth                                                                                        |
|------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| Rank Indicator                                                                           | $\min(2, \lceil \log_2 n_{RI} \rceil)$                                                          |
| Wide-band CQI                                                                            | 4                                                                                               |
| Subband differential CQI                                                                 | 2                                                                                               |
| Indicator of the total number of non-zero coefficients summed across all layers $K^{NZ}$ | $\lceil \log_2(K_0) \rceil$ if max allowed rank is 1;<br>$\lceil \log_2(2K_0) \rceil$ otherwise |

where  $n_{RI}$  is the number of allowed rank indicator values according to Clauses 5.2.2.2.7 [6, TS 38.214],  $K_0 = \lceil K_1 M \beta \rceil$ , where  $K_1$ ,  $M$ , and  $\beta$  are given by Clause 5.2.2.2.7 in [6, TS 38.214]. The values of the rank indicator field are mapped to allowed rank indicator values with increasing order, where '0' is mapped to the smallest allowed rank indicator value. The values of the  $K^{NZ}$  indicator field are mapped to the allowed values of  $K^{NZ}$ , according to Clauses 5.2.2.2.7 [6, TS 38.214], with increasing order, where '0' is mapped to  $K^{NZ} = 1$ .

### 6.3.2.1.3 CG-UCI

For CG-UCI bits transmitted on a CG PUSCH when the higher layer parameter *cg-RetransmissionTimer* is configured, the CG-UCI bit sequence  $a_0, a_1, a_2, a_3, \dots, a_{A-1}$  is determined as follows:

- set  $a_i = \tilde{o}_i^{CG-UCI}$  for  $i = 0, 1, \dots, O^{CG-UCI} - 1$  and  $A = O^{CG-UCI}$ , where the CG-UCI bit sequence  $\tilde{o}_0^{CG-UCI}, \tilde{o}_1^{CG-UCI}, \dots, \tilde{o}_{O^{CG-UCI}-1}^{CG-UCI}$  is given by Table 6.3.2.1.3-1, mapped in the order from upper part to lower part.



Table 6.3.2.1.3-1: Mapping order of CG-UCI fields

| Field                                            | Bitwidth                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| HARQ process number                              | 5 if <i>nrofHARQ-Processes-v1700</i> in <i>ConfiguredGrantConfig</i> is configured;<br>4 otherwise.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Redundancy version                               | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| New data indicator                               | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Channel Occupancy Time (COT) sharing information | <p><math>\lceil \log_2 C \rceil</math> if both higher layer parameter <i>ul-toDL-COT-SharingED-Threshold</i> and higher layer parameter <i>cg-COT-SharingList</i> are configured, or if both higher layer parameter <i>semiStaticChannelAccessConfigUE</i> and higher layer parameter <i>cg-COT-SharingList</i> are configured, or if higher layer parameter <i>cg-COT-SharingList</i> is configured in frequency range 2-2, where <i>C</i> is the number of combinations configured in <i>cg-COT-SharingList</i>;</p> <p>1 if higher layer parameter <i>ul-toDL-COT-SharingED-Threshold</i> is not configured, and if higher layer parameter <i>semiStaticChannelAccessConfigUE</i> is not configured, and if higher layer parameter <i>cg-COT-SharingOffset</i> is configured;</p> <p>0 otherwise.</p> <p>If a UE indicates COT sharing other than "no sharing" in a CG PUSCH within the UE's initiated COT, the UE should provide consistent COT sharing information in all the subsequent CG PUSCHs, if any, occurring within the same UE's initiated COT such that the same DL starting point and duration are maintained.</p> |

#### 6.3.2.1.4 HARQ-ACK and CG-UCI

When higher layer parameter *cg-UCI-Multiplexing* is configured, the UCI bit sequence  $a_0, a_1, a_2, a_3, \dots, a_{A-1}$  is determined as follows, where  $A = O^{CG-UCI} + O^{ACK}$ .

- The CG-UCI bits are mapped to the UCI bit sequence  $a_0, a_1, a_2, a_3, \dots, a_{O^{CG-UCI}-1}$ , where  $a_i = \tilde{o}_i^{CG-UCI}$  for  $i = 0, 1, \dots, O^{CG-UCI} - 1$ . The CG-UCI bit sequence  $\tilde{o}_0^{CG-UCI}, \tilde{o}_1^{CG-UCI}, \dots, \tilde{o}_{O^{CG-UCI}-1}^{CG-UCI}$  is given by Table 6.3.2.1.3-1 mapped in the order from upper part to lower part, and  $O^{CG-UCI}$  is number of CG-UCI bits;
- The HARQ-ACK bits are mapped to the UCI bit sequence  $a_{O^{CG-UCI}}, a_{O^{CG-UCI}+1}, \dots, a_{O^{CG-UCI}+O^{ACK}-1}$ , where  $a_{i+O^{CG-UCI}} = \tilde{o}_i^{ACK}$  for  $i = 0, 1, \dots, O^{ACK} - 1$ . The HARQ-ACK bit sequence  $\tilde{o}_0^{ACK}, \tilde{o}_1^{ACK}, \dots, \tilde{o}_{O^{ACK}-1}^{ACK}$  is given by Clause 9.1 of [5, TS38.213], and  $O^{ACK}$  is number of HARQ-ACK bits.

#### 6.3.2.1.5 UCI with different priority indexes

If *uci-MuxWithDiffPrio* is configured, and HARQ-ACK bits associated with priority index 0, and CSI part 1 if any are transmitted on a PUSCH associated with priority index 1, the following UCI bit sequences are generated,

$a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{A^{(1)}-1}^{(1)}$ , and  $a_0^{(2)}, a_1^{(2)}, a_2^{(2)}, a_3^{(2)}, \dots, a_{A^{(2)}-1}^{(2)}$  if any, according to the following:

- If CSI part 1 is also transmitted on the PUSCH,
  - Set  $a_i^{(1)}$  for  $i = 0, 1, \dots, A^{(1)} - 1$  as the bit sequence of CSI part 1, where the CSI fields of all CSI reports, in the order from upper part to lower part in Table 6.3.2.1.2-6, are mapped to the UCI bit sequence  $a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{A^{(1)}-1}^{(1)}$  starting with  $a_0^{(1)}$ .
- Set  $a_i^{(2)} = \tilde{o}_i^{ACK-LP}$  for  $i = 0, 1, \dots, O^{ACK-LP} - 1$  and  $A^{(2)} = O^{ACK-LP}$ , where the HARQ-ACK bit sequence  $\tilde{o}_0^{ACK-LP}, \tilde{o}_1^{ACK-LP}, \dots, \tilde{o}_{O^{ACK-LP}-1}^{ACK-LP}$  associated with priority index 0 is given by Clause 9.1 of [5, TS 38.213].

- Otherwise, set  $a_i^{(1)} = \tilde{o}_i^{\text{ACK-LP}}$  for  $i = 0, 1, \dots, O^{\text{ACK-LP}} - 1$  and  $A^{(1)} = O^{\text{ACK-LP}}$ , where the HARQ-ACK bit sequence  $\tilde{o}_0^{\text{ACK-LP}}, \tilde{o}_1^{\text{ACK-LP}}, \dots, \tilde{o}_{O^{\text{ACK-LP}}-1}^{\text{ACK-LP}}$  associated with priority index 0 is given by Clause 9.1 of [5, TS 38.213].

If *uci-MuxWithDiffPrio* is configured, and HARQ-ACK bits associated with priority index 1, and CSI if any are transmitted on a PUSCH associated with priority index 0, the following UCI bit sequences are generated,  $a_0, a_1, a_2, a_3, \dots, a_{A-1}, a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{A^{(1)}-1}^{(1)}$  if any, and  $a_0^{(2)}, a_1^{(2)}, a_2^{(2)}, a_3^{(2)}, \dots, a_{A^{(2)}-1}^{(2)}$  if any, according to the following:

- If HARQ-ACK bits associated with priority index 1 and CSI are transmitted on the PUSCH without UL-SCH and the CSI includes CSI part 1 without CSI part 2, and there is only one HARQ-ACK bit associated with priority index 1 given by Clause 9.1 of [5, TS 38.213], set  $a_0 = \tilde{o}_0^{\text{ACK-HP}}, a_1 = 0$ , and  $A = 2$ ; otherwise, set  $a_i = \tilde{o}_i^{\text{ACK-HP}}$  for  $i = 0, 1, \dots, O^{\text{ACK-HP}} - 1$  and  $A = O^{\text{ACK-HP}}$ , where the HARQ-ACK bit sequence  $\tilde{o}_0^{\text{ACK-HP}}, \tilde{o}_1^{\text{ACK-HP}}, \dots, \tilde{o}_{O^{\text{ACK-HP}}-1}^{\text{ACK-HP}}$  associated with priority index 1 is given by Clause 9.1 of [5, TS 38.213];
- Set  $a_i^{(1)}$  for  $i = 0, 1, \dots, A^{(1)} - 1$  as the bit sequence of CSI part 1, if CSI part 1 is also transmitted on the PUSCH, where the CSI fields of all CSI reports, in the order from upper part to lower part in Table 6.3.2.1.2-6, are mapped to the UCI bit sequence  $a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{A^{(1)}-1}^{(1)}$  starting with  $a_0^{(1)}$ ;
- Set  $a_i^{(2)}$  for  $i = 0, 1, \dots, A^{(2)} - 1$  as the bit sequence of CSI part 2, if CSI part 2 is also transmitted on the PUSCH, where the CSI fields of all CSI reports, in the order from upper part to lower part in Table 6.3.2.1.2-7, are mapped to the UCI bit sequence  $a_0^{(2)}, a_1^{(2)}, a_2^{(2)}, a_3^{(2)}, \dots, a_{A^{(2)}-1}^{(2)}$  starting with  $a_0^{(2)}$ .

If *uci-MuxWithDiffPrio* is configured, and HARQ-ACK bits associated with priority index 0, HARQ-ACK bits associated with priority index 1 and/or CG-UCI associated with priority index 1, and CSI part 1 if any are transmitted on a PUSCH, the following UCI bit sequences are generated,  $a_0, a_1, a_2, a_3, \dots, a_{A-1}, a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{A^{(1)}-1}^{(1)}$ , and  $a_0^{(2)}, a_1^{(2)}, a_2^{(2)}, a_3^{(2)}, \dots, a_{A^{(2)}-1}^{(2)}$  if any, according to the following:

- Set  $a_i = \tilde{o}_i^{\text{ACK-HP}}$  for  $i = 0, 1, \dots, O^{\text{ACK-HP}} - 1$  and  $A = O^{\text{ACK-HP}}$  if HARQ-ACK bits associated with priority index 1 are transmitted without CG-UCI associated with priority index 1, where the HARQ-ACK bit sequence  $\tilde{o}_0^{\text{ACK-HP}}, \tilde{o}_1^{\text{ACK-HP}}, \dots, \tilde{o}_{O^{\text{ACK-HP}}-1}^{\text{ACK-HP}}$  associated with priority index 1 is given by Clause 9.1 of [5, TS 38.213];
- Set  $a_i = \tilde{o}_i^{\text{CG-UCI}}$  for  $i = 0, 1, \dots, O^{\text{CG-UCI}} - 1$  and  $A = O^{\text{CG-UCI}}$  if CG-UCI associated with priority index 1 is transmitted without HARQ-ACK bits associated with priority index 1, where the CG-UCI bit sequence  $\tilde{o}_0^{\text{CG-UCI}}, \tilde{o}_1^{\text{CG-UCI}}, \dots, \tilde{o}_{O^{\text{CG-UCI}}-1}^{\text{CG-UCI}}$  associated with priority index 1 is given by Table 6.3.2.1.3-1, mapped in the order from upper part to lower part;
- Set  $a_0, a_1, a_2, a_3, \dots, a_{A-1}$  as follows, if both CG-UCI associated with priority index 1 and HARQ-ACK bits associated with priority index 1 are transmitted, where  $A = O^{\text{CG-UCI}} + O^{\text{ACK-HP}}$ 
  - The CG-UCI bits are mapped to the UCI bit sequence  $a_0, a_1, a_2, a_3, \dots, a_{O^{\text{CG-UCI}}-1}$ , where  $a_i = \tilde{o}_i^{\text{CG-UCI}}$  for  $i = 0, 1, \dots, O^{\text{CG-UCI}} - 1$ . The CG-UCI bit sequence  $\tilde{o}_0^{\text{CG-UCI}}, \tilde{o}_1^{\text{CG-UCI}}, \dots, \tilde{o}_{O^{\text{CG-UCI}}-1}^{\text{CG-UCI}}$  is given by Table 6.3.2.1.3-1 mapped in the order from upper part to lower part, and  $O^{\text{CG-UCI}}$  is number of CG-UCI bits
  - The HARQ-ACK bits are mapped to the UCI bit sequence  $a_{O^{\text{CG-UCI}}}, a_{O^{\text{CG-UCI}}+1}, \dots, a_{O^{\text{CG-UCI}}+O^{\text{ACK-HP}}-1}$ , where  $a_{i+O^{\text{CG-UCI}}} = \tilde{o}_i^{\text{ACK-HP}}$  for  $i = 0, 1, \dots, O^{\text{ACK-HP}} - 1$ . The HARQ-ACK bit sequence  $\tilde{o}_0^{\text{ACK-HP}}, \tilde{o}_1^{\text{ACK-HP}}, \dots, \tilde{o}_{O^{\text{ACK-HP}}-1}^{\text{ACK-HP}}$  associated with priority index 1 is given by Clause 9.1 of [5, TS 38.213].
- If CSI part 1 is also transmitted on the PUSCH and the PUSCH is associated with priority index 1,
  - Set  $a_i^{(1)}$  for  $i = 0, 1, \dots, A^{(1)} - 1$  as the bit sequence of CSI part 1, where the CSI fields of all CSI reports, in the order from upper part to lower part in Table 6.3.2.1.2-6, are mapped to the UCI bit sequence  $a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{A^{(1)}-1}^{(1)}$  starting with  $a_0^{(1)}$ .
  - Set  $a_i^{(2)} = \tilde{o}_i^{\text{ACK-LP}}$  for  $i = 0, 1, \dots, O^{\text{ACK-LP}} - 1$  and  $A^{(2)} = O^{\text{ACK-LP}}$ , where the HARQ-ACK bit sequence  $\tilde{o}_0^{\text{ACK-LP}}, \tilde{o}_1^{\text{ACK-LP}}, \dots, \tilde{o}_{O^{\text{ACK-LP}}-1}^{\text{ACK-LP}}$  associated with priority index 0 is given by Clause 9.1 of [5, TS 38.213].
- Otherwise,

- Set  $a_i^{(1)} = \tilde{o}_i^{\text{ACK-LP}}$  for  $i = 0, 1, \dots, O^{\text{ACK-LP}} - 1$  and  $A^{(1)} = O^{\text{ACK-LP}}$ , where the HARQ-ACK bit sequence  $\tilde{o}_0^{\text{ACK-LP}}, \tilde{o}_1^{\text{ACK-LP}}, \dots, \tilde{o}_{O^{\text{ACK-LP}}-1}^{\text{ACK-LP}}$  associated with priority index 0 is given by Clause 9.1 of [5, TS 38.213].
- Set  $a_i^{(2)} = \tilde{a}_i^{(1)}$  for  $i = 0, 1, \dots, \tilde{A}^{(1)} - 1$  and  $A^{(2)} = \tilde{A}^{(1)}$ , if CSI part 1 is also transmitted on the PUSCH and the PUSCH is associated with priority index 0, where the CSI part 1 sequence  $\tilde{a}_0^{(1)}, \tilde{a}_1^{(1)}, \tilde{a}_2^{(1)}, \tilde{a}_3^{(1)}, \dots, \tilde{a}_{\tilde{A}^{(1)}-1}^{(1)}$  is given by Table 6.3.2.1.2-6 by replacing  $a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{A^{(1)}-1}^{(1)}$ , and the CSI fields of all CSI reports, in the order from upper part to lower part in Table 6.3.2.1.2-6, are mapped to the CSI part 1 sequence  $\tilde{a}_0^{(1)}, \tilde{a}_1^{(1)}, \tilde{a}_2^{(1)}, \tilde{a}_3^{(1)}, \dots, \tilde{a}_{\tilde{A}^{(1)}-1}^{(1)}$  starting with  $\tilde{a}_0^{(1)}$ .

If *uci-MuxWithDiffPrio* is configured, and CG-UCI associated with priority index 0 and HARQ-ACK bits associated with priority index 0 if any, HARQ-ACK bits associated with priority index 1, and CSI part 1 if any are transmitted on a PUSCH associated with priority index 0, the following UCI bit sequences are generated,  $a_0, a_1, a_2, a_3, \dots, a_{A-1}$ ,  $a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{A^{(1)}-1}^{(1)}$ , and  $a_0^{(2)}, a_1^{(2)}, a_2^{(2)}, a_3^{(2)}, \dots, a_{A^{(2)}-1}^{(2)}$  if any, according to the following:

- Set  $a_i = \tilde{o}_i^{\text{ACK-HP}}$  for  $i = 0, 1, \dots, O^{\text{ACK-HP}} - 1$  and  $A = O^{\text{ACK-HP}}$ , where the HARQ-ACK bit sequence  $\tilde{o}_0^{\text{ACK-HP}}, \tilde{o}_1^{\text{ACK-HP}}, \dots, \tilde{o}_{O^{\text{ACK-HP}}-1}^{\text{ACK-HP}}$  associated with priority index 1 is given by Clause 9.1 of [5, TS 38.213];
- Set  $a_i^{(1)} = \tilde{o}_i^{\text{CG-UCI}}$  for  $i = 0, 1, \dots, O^{\text{CG-UCI}} - 1$  and  $A^{(1)} = O^{\text{CG-UCI}}$  if CG-UCI associated with priority index 0 is transmitted without HARQ-ACK bits associated with priority index 0, where the CG-UCI bit sequence  $\tilde{o}_0^{\text{CG-UCI}}, \tilde{o}_1^{\text{CG-UCI}}, \dots, \tilde{o}_{O^{\text{CG-UCI}}-1}^{\text{CG-UCI}}$  associated with priority index 0 is given by Table 6.3.2.1.3-1, mapped in the order from upper part to lower part;
- Set  $a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{A^{(1)}-1}^{(1)}$  as follows if both CG-UCI associated with priority index 0 and HARQ-ACK bits associated with priority index 0 are transmitted, where  $A^{(1)} = O^{\text{CG-UCI}} + O^{\text{ACK-LP}}$ 
  - The CG-UCI bits are mapped to the UCI bit sequence  $a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{O^{\text{CG-UCI}}-1}^{(1)}$ , where  $a_i^{(1)} = \tilde{o}_i^{\text{CG-UCI}}$  for  $i = 0, 1, \dots, O^{\text{CG-UCI}} - 1$ . The CG-UCI bit sequence  $\tilde{o}_0^{\text{CG-UCI}}, \tilde{o}_1^{\text{CG-UCI}}, \dots, \tilde{o}_{O^{\text{CG-UCI}}-1}^{\text{CG-UCI}}$  is given by Table 6.3.2.1.3-1 mapped in the order from upper part to lower part, and  $O^{\text{CG-UCI}}$  is number of CG-UCI bits
  - The HARQ-ACK bits are mapped to the UCI bit sequence  $a_{O^{\text{CG-UCI}}}^{(1)}, a_{O^{\text{CG-UCI}}+1}^{(1)}, \dots, a_{O^{\text{CG-UCI}}+O^{\text{ACK-LP}}-1}^{(1)}$ , where  $a_{i+O^{\text{CG-UCI}}}^{(1)} = \tilde{o}_i^{\text{ACK-LP}}$  for  $i = 0, 1, \dots, O^{\text{ACK-LP}} - 1$ . The HARQ-ACK bit sequence  $\tilde{o}_0^{\text{ACK-LP}}, \tilde{o}_1^{\text{ACK-LP}}, \dots, \tilde{o}_{O^{\text{ACK-LP}}-1}^{\text{ACK-LP}}$  associated with priority index 0 is given by Clause 9.1 of [5, TS 38.213].
- Set  $a_i^{(2)} = \tilde{a}_i^{(1)}$  for  $i = 0, 1, \dots, \tilde{A}^{(1)} - 1$  and  $A^{(2)} = \tilde{A}^{(1)}$ , if CSI part 1 is also transmitted on the PUSCH and the PUSCH is associated with priority index 0, where the CSI part 1 sequence  $\tilde{a}_0^{(1)}, \tilde{a}_1^{(1)}, \tilde{a}_2^{(1)}, \tilde{a}_3^{(1)}, \dots, \tilde{a}_{\tilde{A}^{(1)}-1}^{(1)}$  is given by Table 6.3.2.1.2-6 by replacing  $a_0^{(1)}, a_1^{(1)}, a_2^{(1)}, a_3^{(1)}, \dots, a_{A^{(1)}-1}^{(1)}$ , and the CSI fields of all CSI reports, in the order from upper part to lower part in Table 6.3.2.1.2-6, are mapped to the CSI part 1 sequence  $\tilde{a}_0^{(1)}, \tilde{a}_1^{(1)}, \tilde{a}_2^{(1)}, \tilde{a}_3^{(1)}, \dots, \tilde{a}_{\tilde{A}^{(1)}-1}^{(1)}$  starting with  $\tilde{a}_0^{(1)}$ .

### 6.3.2.2 Code block segmentation and CRC attachment

Denote the bits of the payload by  $a_0, a_1, a_2, a_3, \dots, a_{A-1}$ , where  $A$  is the payload size. The procedure in 6.3.2.2.1 applies for  $A \geq 12$  and the procedure in Clause 6.3.2.2.2 applies for  $A \leq 11$ .

#### 6.3.2.2.1 UCI encoded by Polar code

Code block segmentation and CRC attachment is performed according to Clause 6.3.1.2.1.

#### 6.3.2.2.2 UCI encoded by channel coding of small block lengths

The procedure in Clause 6.3.1.2.2 applies.

### 6.3.2.3 Channel coding of UCI

#### 6.3.2.3.1 UCI encoded by Polar code

Channel coding is performed according to Clause 6.3.1.3.1, except that the rate matching output sequence length  $E_r$  is given in Clause 6.3.2.4.1.

#### 6.3.2.3.2 UCI encoded by channel coding of small block lengths

Information bits are delivered to the channel coding block. They are denoted by  $c_0, c_1, c_2, c_3, \dots, c_{K-1}$ , where  $K$  is the number of bits.

The information bits are encoded according to Clause 5.3.3.

After encoding the bits are denoted by  $d_0, d_1, d_2, d_3, \dots, d_{N-1}$ , where  $N$  is the number of coded bits.

### 6.3.2.4 Rate matching

#### 6.3.2.4.1 UCI encoded by Polar code

##### 6.3.2.4.1.1 HARQ-ACK

For HARQ-ACK transmission on PUSCH not using repetition type B with UL-SCH and if *numberOfSlotsTBoMS* is not present in the resource allocation table, or if *numberOfSlotsTBoMS* is present in the resource allocation table and the value of *numberOfSlotsTBoMS* in the row indicated by the Time domain resource assignment field in DCI is equal to 1, the number of coded modulation symbols per layer for HARQ-ACK transmission, denoted as  $Q'_{ACK}$ , is determined as follows:

$$Q'_{ACK} = \min \left\{ \left\lceil \frac{(O_{ACK} + L_{ACK}) \cdot \beta_{offset}^{PUSCH} \cdot \sum_{l=0}^{N_{symb,all}^{PUSCH}-1} M_{sc}^{UCI}(l)}{\sum_{r=0}^{C_{UL-SCH}-1} K_r} \right\rceil, \left\lceil \alpha \cdot \sum_{l=l_0}^{N_{symb,all}^{PUSCH}-1} M_{sc}^{UCI}(l) \right\rceil \right\}$$

where

- $O_{ACK}$  is the number of HARQ-ACK bits;
- if  $O_{ACK} \geq 360$ ,  $L_{ACK} = 11$ ; otherwise  $L_{ACK}$  is the number of CRC bits for HARQ-ACK determined according to Clause 6.3.1.2.1;
- $\beta_{offset}^{PUSCH} = \beta_{offset}^{HARQ-ACK}$ ;
- $C_{UL-SCH}$  is the number of code blocks for UL-SCH of the PUSCH transmission;
- if the DCI format scheduling the PUSCH transmission includes a CBGTI field indicating that the UE shall not transmit the  $r$ -th code block,  $K_r = 0$ ; otherwise,  $K_r$  is the  $r$ -th code block size for UL-SCH of the PUSCH transmission;
- $M_{sc}^{PUSCH}$  is the scheduled bandwidth of the PUSCH transmission, expressed as a number of subcarriers;
- $M_{sc}^{PT-RS}(l)$  is the number of subcarriers in OFDM symbol  $l$  that carries PTRS, in the PUSCH transmission;

- $M_{sc}^{UCI}(l)$  is the number of resource elements that can be used for transmission of UCI in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{\text{symb,all}}^{\text{PUSCH}} - 1$ , in the PUSCH transmission and  $N_{\text{symb,all}}^{\text{PUSCH}}$  is the total number of OFDM symbols of the PUSCH, including all OFDM symbols used for DMRS;
- for any OFDM symbol that carries DMRS of the PUSCH,  $M_{sc}^{UCI}(l) = 0$ ;
- for any OFDM symbol that does not carry DMRS of the PUSCH,  $M_{sc}^{UCI}(l) = M_{sc}^{\text{PUSCH}} - M_{sc}^{\text{PT-RS}}(l)$ ;
- $\alpha$  is configured by higher layer parameter *scaling*;
- $l_0$  is the symbol index of the first OFDM symbol that does not carry DMRS of the PUSCH, after the first DMRS symbol(s), in the PUSCH transmission.

For HARQ-ACK transmission on PUSCH not using repetition type B with UL-SCH, and if *numberOfSlotsTBoMS* is present in the resource allocation table and the value of *numberOfSlotsTBoMS* in the row indicated by the Time domain resource assignment field in DCI is larger than 1, the number of coded modulation symbols per layer for HARQ-ACK transmission, denoted as  $Q'_{ACK}$ , is determined as follows:

$$Q'_{ACK} = \min \left\{ \left\lceil \frac{(O_{ACK} + L_{ACK}) \cdot \beta_{\text{offset}}^{\text{PUSCH}} \cdot \sum_{l=0}^{N_{\text{symb,all}}^{\text{PUSCH}} - 1} M_{sc}^{UCI}(l)}{\frac{1}{N_s} \sum_{r=0}^{C_{\text{UL-SCH}} - 1} K_r} \right\rceil, \left\lceil \alpha \cdot \sum_{l=l_0}^{N_{\text{symb,all}}^{\text{PUSCH}} - 1} M_{sc}^{UCI}(l) \right\rceil \right\}$$

where

- $N_s$  is the value of *numberOfSlotsTBoMS* in the row indicated by the Time domain resource assignment field in DCI;
- $M_{sc}^{\text{PT-RS}}(l)$  is the number of subcarriers in OFDM symbol  $l$  that carries PTRS, in the PUSCH transmission of TB processing over multiple slots in the slot with the HARQ-ACK transmission;
- $M_{sc}^{UCI}(l)$  is the number of resource elements that can be used for transmission of UCI in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{\text{symb,all}}^{\text{PUSCH}} - 1$ , in the PUSCH transmission of TB processing over multiple slots in the slot with the HARQ-ACK transmission and  $N_{\text{symb,all}}^{\text{PUSCH}}$  is the total number of OFDM symbols of the PUSCH in the slot, including all OFDM symbols used for DMRS;
- $l_0$  is the symbol index of the first OFDM symbol that does not carry DMRS of the PUSCH, after the first DMRS symbol(s), in the PUSCH transmission of TB processing over multiple slots in the slot with the HARQ-ACK transmission;
- and all the other notations in the formula are defined the same as for PUSCH not using repetition type B and if *numberOfSlotsTBoMS* is not present in the resource allocation table.

For HARQ-ACK transmission on an actual repetition of a PUSCH with repetition Type B with UL-SCH, the number of coded modulation symbols per layer for HARQ-ACK transmission, denoted as  $Q'_{ACK}$ , is determined as follows:

$$Q'_{ACK} = \min \left\{ \left\lceil \frac{(O_{ACK} + L_{ACK}) \cdot \beta_{\text{offset}}^{\text{PUSCH}} \cdot \sum_{l=0}^{N_{\text{symb,nominal}}^{\text{PUSCH}} - 1} M_{sc,\text{nominal}}^{UCI}(l)}{\sum_{r=0}^{C_{\text{UL-SCH}} - 1} K_r} \right\rceil, \left\lceil \alpha \cdot \sum_{l=0}^{N_{\text{symb,nominal}}^{\text{PUSCH}} - 1} M_{sc,\text{nominal}}^{UCI}(l) \right\rceil, \sum_{l=0}^{N_{\text{symb,actual}}^{\text{PUSCH}} - 1} M_{sc,\text{actual}}^{UCI}(l) \right\}$$

where

- $M_{sc,nominal}^{UCI}(l)$  is the number of resource elements that can be used for transmission of UCI in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{symb,nominal}^{PUSCH} - 1$ , in the PUSCH transmission assuming a nominal repetition without segmentation, and  $N_{symb,nominal}^{PUSCH}$  is the total number of OFDM symbols in a nominal repetition of the PUSCH, including all OFDM symbols used for DMRS;
- for any OFDM symbol that carries DMRS of the PUSCH assuming a nominal repetition without segmentation,  $M_{sc,nominal}^{UCI}(l) = 0$ ;
- for any OFDM symbol that does not carry DMRS of the PUSCH assuming a nominal repetition without segmentation,  $M_{sc,nominal}^{UCI}(l) = M_{sc}^{PUSCH} - M_{sc,nominal}^{PT-RS}(l)$  where  $M_{sc,nominal}^{PT-RS}(l)$  is the number of subcarriers in OFDM symbol  $l$  that carries PTRS, in the PUSCH transmission assuming a nominal repetition without segmentation;
- $M_{sc,actual}^{UCI}(l)$  is the number of resource elements that can be used for transmission of UCI in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{symb,actual}^{PUSCH} - 1$ , in the actual repetition of the PUSCH transmission, and  $N_{symb,actual}^{PUSCH}$  is the total number of OFDM symbols in the actual repetition of the PUSCH transmission, including all OFDM symbols used for DMRS;
- for any OFDM symbol that carries DMRS of the actual repetition of the PUSCH transmission,  $M_{sc,actual}^{UCI}(l) = 0$ ;
- for any OFDM symbol that does not carry DMRS of the actual repetition of the PUSCH transmission,  $M_{sc,actual}^{UCI}(l) = M_{sc}^{PUSCH} - M_{sc,actual}^{PT-RS}(l)$  where  $M_{sc,actual}^{PT-RS}(l)$  is the number of subcarriers in OFDM symbol  $l$  that carries PTRS, in the actual repetition of the PUSCH transmission;
- and all the other notations in the formula are defined the same as for PUSCH not using repetition type B and if *numberOfSlotsTBoMS* is not present in the resource allocation table.

For HARQ-ACK transmission on PUSCH without UL-SCH, the number of coded modulation symbols per layer for HARQ-ACK transmission, denoted as  $Q'_{ACK}$ , is determined as follows:

$$Q'_{ACK} = \min \left\{ \left\lceil \frac{(O_{ACK} + L_{ACK}) \cdot \beta_{offset}^{PUSCH}}{R \cdot Q_m} \right\rceil, \left\lceil \alpha \cdot \sum_{l=l_0}^{N_{symb,all}^{PUSCH}-1} M_{sc}^{UCI}(l) \right\rceil \right\}$$

where

- $O_{ACK}$  is the number of HARQ-ACK bits;
- if  $O_{ACK} \geq 360$ ,  $L_{ACK} = 11$ ; otherwise  $L_{ACK}$  is the number of CRC bits for HARQ-ACK defined according to Clause 6.3.1.2.1;
- $\beta_{offset}^{PUSCH} = \beta_{offset}^{HARQ-ACK}$ ;
- $M_{sc}^{PUSCH}$  is the scheduled bandwidth of the PUSCH transmission, expressed as a number of subcarriers;
- $M_{sc}^{PT-RS}(l)$  is the number of subcarriers in OFDM symbol  $l$  that carries PTRS, in the PUSCH transmission;
- $M_{sc}^{UCI}(l)$  is the number of resource elements that can be used for transmission of UCI in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{symb,all}^{PUSCH} - 1$ , in the PUSCH transmission and  $N_{symb,all}^{PUSCH}$  is the total number of OFDM symbols of the PUSCH, including all OFDM symbols used for DMRS;
- for any OFDM symbol that carries DMRS of the PUSCH,  $M_{sc}^{UCI}(l) = 0$ ;
- for any OFDM symbol that does not carry DMRS of the PUSCH,  $M_{sc}^{UCI}(l) = M_{sc}^{PUSCH} - M_{sc}^{PT-RS}(l)$ ;

- $l_0$  is the symbol index of the first OFDM symbol that does not carry DMRS of the PUSCH, after the first DMRS symbol(s), in the PUSCH transmission;
- $R$  is the code rate of the PUSCH, determined according to Clause 6.1.4.1 of [6, TS38.214];
- $Q_m$  is the modulation order of the PUSCH;
- $\alpha$  is configured by higher layer parameter *scaling*.

The input bit sequence to rate matching is  $d_{r0}, d_{r1}, d_{r2}, d_{r3}, \dots, d_{r(N_r-1)}$  where  $r$  is the code block number, and  $N_r$  is the number of coded bits in code block number  $r$ .

Rate matching is performed according to Clause 5.4.1 by setting  $I_{BL} = 1$  and the rate matching output sequence length to  $E_r = \lfloor E_{UCI} / C_{UCI} \rfloor$ , where

- $C_{UCI}$  is the number of code blocks for UCI determined according to Clause 5.2.1;
- $N_L$  is the number of transmission layers of the PUSCH;
- $Q_m$  is the modulation order of the PUSCH;
- $E_{UCI} = N_L \cdot Q'_{ACK} \cdot Q_m$ .

The output bit sequence after rate matching is denoted as  $f_{r0}, f_{r1}, f_{r2}, \dots, f_{r(E_r-1)}$  where  $E_r$  is the length of rate matching output sequence in code block number  $r$ .

#### 6.3.2.4.1.2 CSI part 1

For CSI part 1 transmission on PUSCH not using repetition type B with UL-SCH and if *numberOfSlotsTBoMS* is not present in the resource allocation table, or if *numberOfSlotsTBoMS* is present in the resource allocation table and the value of *numberOfSlotsTBoMS* in the row indicated by the Time domain resource assignment field in DCI is equal to 1, the number of coded modulation symbols per layer for CSI part 1 transmission, denoted as  $Q'_{CSI-part1}$ , is determined as follows:

$$Q'_{CSI-1} = \min \left\{ \left\lceil \frac{(O_{CSI-1} + L_{CSI-1}) \cdot \beta_{offset}^{PUSCH} \cdot \sum_{l=0}^{N_{symb,all}^{PUSCH}-1} M_{sc}^{UCI}(l)}{\sum_{r=0}^{C_{UL-SCH}-1} K_r} \right\rceil, \left\lceil \alpha \cdot \sum_{l=0}^{N_{symb,all}^{PUSCH}-1} M_{sc}^{UCI}(l) \right\rceil - Q'_{ACK/CG-UCI} \right\}$$

where

- $O_{CSI-1}$  is the number of bits for CSI part 1;
- if  $O_{CSI-1} \geq 360$ ,  $L_{CSI-1} = 11$ ; otherwise  $L_{CSI-1}$  is the number of CRC bits for CSI part 1 determined according to Clause 6.3.1.2.1;
- $\beta_{offset}^{PUSCH} = \beta_{offset}^{CSI-part1}$ ;
- $C_{UL-SCH}$  is the number of code blocks for UL-SCH of the PUSCH transmission;
- if the DCI format scheduling the PUSCH transmission includes a CBGTI field indicating that the UE shall not transmit the  $r$ -th code block,  $K_r = 0$ ; otherwise,  $K_r$  is the  $r$ -th code block size for UL-SCH of the PUSCH transmission;
- $M_{sc}^{PUSCH}$  is the scheduled bandwidth of the PUSCH transmission, expressed as a number of subcarriers;

- $M_{sc}^{PT-RS}(l)$  is the number of subcarriers in OFDM symbol  $l$  that carries PTRS, in the PUSCH transmission;
- $Q'_{ACK/CG-UCI} = Q'_{ACK}$  if HARQ-ACK is present for transmission on the same PUSCH with UL-SCH and without CG-UCI, where  $Q'_{ACK}$  is the number of coded modulation symbols per layer for HARQ-ACK transmitted on the PUSCH as defined in clause 6.3.2.4.1.1 if number of HARQ-ACK information bits is more than 2, and
 
$$Q'_{ACK} = \sum_{l=0}^{N_{\text{symb,all}}^{\text{PUSCH}}-1} \bar{M}_{sc,rvd}^{\text{ACK}}(l)$$
 if the number of HARQ-ACK information bits is no more than 2 bits, where  $\bar{M}_{sc,rvd}^{\text{ACK}}(l)$  is the number of reserved resource elements for potential HARQ-ACK transmission in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{\text{symb,all}}^{\text{PUSCH}} - 1$ , in the PUSCH transmission, defined in Clause 6.2.7; or
- $Q'_{ACK/CG-UCI} = Q'_{ACK}$  if both HARQ-ACK and CG-UCI are present on the same PUSCH with UL-SCH, where  $Q'_{ACK}$  is the number of coded modulation symbols per layer for HARQ-ACK and CG-UCI transmitted on the PUSCH as defined in clause 6.3.2.4.1.5; or
- $Q'_{ACK/CG-UCI} = Q'_{CG-UCI}$  if CG-UCI is present on the same PUSCH with UL-SCH and without HARQ-ACK, where  $Q'_{CG-UCI}$  is the number of coded modulation symbols per layer for CG-UCI transmitted on the PUSCH as defined in clause 6.3.2.4.1.4;
- $M_{sc}^{\text{UCI}}(l)$  is the number of resource elements that can be used for transmission of UCI in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{\text{symb,all}}^{\text{PUSCH}} - 1$ , in the PUSCH transmission and  $N_{\text{symb,all}}^{\text{PUSCH}}$  is the total number of OFDM symbols of the PUSCH, including all OFDM symbols used for DMRS;
  - for any OFDM symbol that carries DMRS of the PUSCH,  $M_{sc}^{\text{UCI}}(l) = 0$ ;
  - for any OFDM symbol that does not carry DMRS of the PUSCH,  $M_{sc}^{\text{UCI}}(l) = M_{sc}^{\text{PUSCH}} - M_{sc}^{\text{PT-RS}}(l)$ ;
- $\alpha$  is configured by higher layer parameter *scaling*.

For CSI part 1 transmission on PUSCH not using repetition type B with UL-SCH, and if *numberOfSlotsTBoMS* is present in the resource allocation table and the value of *numberOfSlotsTBoMS* in the row indicated by the Time domain resource assignment field in DCI is larger than 1, the number of coded modulation symbols per layer for CSI part 1 transmission, denoted as  $Q'_{\text{CSI-part1}}$ , is determined as follows:

$$Q'_{\text{CSI-1}} = \min \left\{ \left\lceil \frac{(O_{\text{CSI-1}} + L_{\text{CSI-1}}) \cdot \beta_{\text{offset}}^{\text{PUSCH}} \cdot \sum_{l=0}^{N_{\text{symb,all}}^{\text{PUSCH}}-1} M_{sc}^{\text{UCI}}(l)}{\frac{1}{N_s} \sum_{r=0}^{C_{\text{UL-SCH}}-1} K_r} \right\rceil, \left\lceil \alpha \cdot \sum_{l=0}^{N_{\text{symb,all}}^{\text{PUSCH}}-1} M_{sc}^{\text{UCI}}(l) \right\rceil - Q'_{\text{ACK/CG-UCI}} \right\}$$

where

- $N_s$  is the value of *numberOfSlotsTBoMS* in the row indicated by the Time domain resource assignment field in DCI;
- $M_{sc}^{\text{PT-RS}}(l)$  is the number of subcarriers in OFDM symbol  $l$  that carries PTRS, in the PUSCH transmission of TB processing over multiple slots in the slot with the CSI part 1 transmission;
- $M_{sc}^{\text{UCI}}(l)$  is the number of resource elements that can be used for transmission of UCI in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{\text{symb,all}}^{\text{PUSCH}} - 1$ , in the PUSCH transmission of TB processing over multiple slots in the slot with the CSI part 1 transmission and  $N_{\text{symb,all}}^{\text{PUSCH}}$  is the total number of OFDM symbols of the PUSCH in the slot, including all OFDM symbols used for DMRS;
- and all the other notations in the formula are defined the same as for PUSCH not using repetition type B and if *numberOfSlotsTBoMS* is not present in the resource allocation table.



For CSI part 1 transmission on an actual repetition of a PUSCH with repetition Type B with UL-SCH, the number of coded modulation symbols per layer for CSI part 1 transmission, denoted as  $Q'_{\text{CSI-part1}}$ , is determined as follows:

$$Q'_{\text{CSI-1}} = \min \left\{ \left\lceil \frac{(O_{\text{CSI-1}} + L_{\text{CSI-1}}) \cdot \beta_{\text{offset}}^{\text{PUSCH}} \cdot \sum_{l=0}^{N_{\text{symb,nominal}}^{\text{PUSCH}} - 1} M_{\text{sc,nominal}}^{\text{UCI}}(l)}{\sum_{r=0}^{C_{\text{UL-SCH}} - 1} K_r} \right\rceil, \left\lceil \alpha \cdot \sum_{l=0}^{N_{\text{symb,nominal}}^{\text{PUSCH}} - 1} M_{\text{sc,nominal}}^{\text{UCI}}(l) \right\rceil \right. \\ \left. - Q'_{\text{ACK/CG-UCI}}, \sum_{l=0}^{N_{\text{symb,actual}}^{\text{PUSCH}} - 1} M_{\text{sc,actual}}^{\text{UCI}}(l) - Q'_{\text{ACK/CG-UCI}} \right\}$$

where

- $M_{\text{sc,nominal}}^{\text{UCI}}(l)$  is the number of resource elements that can be used for transmission of UCI in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{\text{symb,nominal}}^{\text{PUSCH}} - 1$ , in the PUSCH transmission assuming a nominal repetition without segmentation, and  $N_{\text{symb,nominal}}^{\text{PUSCH}}$  is the total number of OFDM symbols in a nominal repetition of the PUSCH, including all OFDM symbols used for DMRS;
- for any OFDM symbol that carries DMRS of the PUSCH assuming a nominal repetition without segmentation,  $M_{\text{sc,nominal}}^{\text{UCI}}(l) = 0$ ;
- for any OFDM symbol that does not carry DMRS of the PUSCH assuming a nominal repetition without segmentation,  $M_{\text{sc,nominal}}^{\text{UCI}}(l) = M_{\text{sc}}^{\text{PUSCH}} - M_{\text{sc,nominal}}^{\text{PT-RS}}(l)$  where  $M_{\text{sc,nominal}}^{\text{PT-RS}}(l)$  is the number of subcarriers in OFDM symbol  $l$  that carries PTRS, in the PUSCH transmission assuming a nominal repetition without segmentation;
- $M_{\text{sc,actual}}^{\text{UCI}}(l)$  is the number of resource elements that can be used for transmission of UCI in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{\text{symb,actual}}^{\text{PUSCH}} - 1$ , in the actual repetition of the PUSCH transmission, and  $N_{\text{symb,actual}}^{\text{PUSCH}}$  is the total number of OFDM symbols in the actual repetition of the PUSCH transmission, including all OFDM symbols used for DMRS;
- for any OFDM symbol that carries DMRS of the actual repetition of the PUSCH transmission,  $M_{\text{sc,actual}}^{\text{UCI}}(l) = 0$ ;
- for any OFDM symbol that does not carry DMRS of the actual repetition of the PUSCH transmission,  $M_{\text{sc,actual}}^{\text{UCI}}(l) = M_{\text{sc}}^{\text{PUSCH}} - M_{\text{sc,actual}}^{\text{PT-RS}}(l)$  where  $M_{\text{sc,actual}}^{\text{PT-RS}}(l)$  is the number of subcarriers in OFDM symbol  $l$  that carries PTRS, in the actual repetition of the PUSCH transmission;
- and all the other notations in the formula are defined the same as for PUSCH not using repetition type B and if *numberOfSlotsTBoMS* is not present in the resource allocation table.

For CSI part 1 transmission on PUSCH without UL-SCH, the number of coded modulation symbols per layer for CSI part 1 transmission, denoted as  $Q'_{\text{CSI-part1}}$ , is determined as follows:

if there is CSI part 2 to be transmitted on the PUSCH,

$$Q'_{\text{CSI-1}} = \min \left\{ \left\lceil \frac{(O_{\text{CSI-1}} + L_{\text{CSI-1}}) \cdot \beta_{\text{offset}}^{\text{PUSCH}}}{R \cdot Q_m} \right\rceil, \sum_{l=0}^{N_{\text{symb,all}}^{\text{PUSCH}} - 1} M_{\text{sc}}^{\text{UCI}}(l) - Q'_{\text{ACK}} \right\}$$

else

$$Q'_{\text{CSI-1}} = \sum_{l=0}^{N_{\text{symb,all}}^{\text{PUSCH}} - 1} M_{\text{sc}}^{\text{UCI}}(l) - Q'_{\text{ACK}}$$

end if

where

- $O_{\text{CSI-1}}$  is the number of bits for CSI part 1;
- if  $O_{\text{CSI-1}} \geq 360$ ,  $L_{\text{CSI-1}} = 11$ ; otherwise  $L_{\text{CSI-1}}$  is the number of CRC bits for CSI part 1 determined according to Clause 6.3.1.2.1;
- $\beta_{\text{offset}}^{\text{PUSCH}} = \beta_{\text{offset}}^{\text{CSI-part1}}$ ;
- $M_{\text{sc}}^{\text{PUSCH}}$  is the scheduled bandwidth of the PUSCH transmission, expressed as a number of subcarriers;
- $M_{\text{sc}}^{\text{PT-RS}}(l)$  is the number of subcarriers in OFDM symbol  $l$  that carries PTRS, in the PUSCH transmission;
- $Q'_{\text{ACK}}$  is the number of coded modulation symbols per layer for HARQ-ACK transmitted on the PUSCH if number of HARQ-ACK information bits is more than 2, and  $Q'_{\text{ACK}} = \sum_{l=0}^{N_{\text{symb,all}}^{\text{PUSCH}}-1} \bar{M}_{\text{sc,rvd}}^{\text{ACK}}(l)$  if the number of HARQ-ACK information bits is no more than 2 bits, where  $\bar{M}_{\text{sc,rvd}}^{\text{ACK}}(l)$  is the number of reserved resource elements for potential HARQ-ACK transmission in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{\text{symb,all}}^{\text{PUSCH}} - 1$ , in the PUSCH transmission, defined in Clause 6.2.7;
- $M_{\text{sc}}^{\text{UCI}}(l)$  is the number of resource elements that can be used for transmission of UCI in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{\text{symb,all}}^{\text{PUSCH}} - 1$ , in the PUSCH transmission and  $N_{\text{symb,all}}^{\text{PUSCH}}$  is the total number of OFDM symbols of the PUSCH, including all OFDM symbols used for DMRS;
  - for any OFDM symbol that carries DMRS of the PUSCH,  $M_{\text{sc}}^{\text{UCI}}(l) = 0$ ;
  - for any OFDM symbol that does not carry DMRS of the PUSCH,  $M_{\text{sc}}^{\text{UCI}}(l) = M_{\text{sc}}^{\text{PUSCH}} - M_{\text{sc}}^{\text{PT-RS}}(l)$ ;
- $R$  is the code rate of the PUSCH, determined according to Clause 6.1.4.1 of [6, TS38.214];
- $Q_m$  is the modulation order of the PUSCH.

The input bit sequence to rate matching is  $d_{r0}, d_{r1}, d_{r2}, d_{r3}, \dots, d_{r(N_r-1)}$  where  $r$  is the code block number, and  $N_r$  is the number of coded bits in code block number  $r$ .

Rate matching is performed according to Clause 5.4.1 by setting  $I_{\text{BIL}} = 1$  and the rate matching output sequence length to  $E_r = \lfloor E_{\text{UCI}} / C_{\text{UCI}} \rfloor$ , where

- $C_{\text{UCI}}$  is the number of code blocks for UCI determined according to Clause 5.2.1;
- $N_L$  is the number of transmission layers of the PUSCH;
- $Q_m$  is the modulation order of the PUSCH;
- $E_{\text{UCI}} = N_L \cdot Q'_{\text{CSI-1}} \cdot Q_m$ .

The output bit sequence after rate matching is denoted as  $f_{r0}, f_{r1}, f_{r2}, \dots, f_{r(E_r-1)}$  where  $E_r$  is the length of rate matching output sequence in code block number  $r$ .

## 6.3.2.4.1.3 CSI part 2

For CSI part 2 transmission on PUSCH not using repetition type B with UL-SCH and if *numberOfSlotsTBoMS* is not present in the resource allocation table, or if *numberOfSlotsTBoMS* is present in the resource allocation table and the value of *numberOfSlotsTBoMS* in the row indicated by the Time domain resource assignment field in DCI is equal to 1, the number of coded modulation symbols per layer for CSI part 2 transmission, denoted as  $Q'_{\text{CSI-part2}}$ , is determined as follows:

$$Q'_{\text{CSI-2}} = \min \left\{ \left\lceil \frac{(O_{\text{CSI-2}} + L_{\text{CSI-2}}) \cdot \beta_{\text{offset}}^{\text{PUSCH}} \sum_{l=0}^{N_{\text{symb,all}}^{\text{PUSCH}} - 1} M_{\text{sc}}^{\text{UCI}}(l)}{\sum_{r=0}^{C_{\text{UL-SCH}} - 1} K_r} \right\rceil, \left\lceil \alpha \cdot \sum_{l=0}^{N_{\text{symb,all}}^{\text{PUSCH}} - 1} M_{\text{sc}}^{\text{UCI}}(l) \right\rceil - Q'_{\text{ACK/CG-UCI}} - Q'_{\text{CSI-1}} \right\}$$

where

- $O_{\text{CSI-2}}$  is the number of bits for CSI part 2;
- if  $O_{\text{CSI-2}} \geq 360$ ,  $L_{\text{CSI-2}} = 11$ ; otherwise  $L_{\text{CSI-2}}$  is the number of CRC bits for CSI part 2 determined according to Clause 6.3.1.2.1;
- $\beta_{\text{offset}}^{\text{PUSCH}} = \beta_{\text{offset}}^{\text{CSI-part2}}$ ;
- $C_{\text{UL-SCH}}$  is the number of code blocks for UL-SCH of the PUSCH transmission;
- if the DCI format scheduling the PUSCH transmission includes a CBGTI field indicating that the UE shall not transmit the  $r$ -th code block,  $K_r = 0$ ; otherwise,  $K_r$  is the  $r$ -th code block size for UL-SCH of the PUSCH transmission;
- $M_{\text{sc}}^{\text{PUSCH}}$  is the scheduled bandwidth of the PUSCH transmission, expressed as a number of subcarriers;
- $M_{\text{sc}}^{\text{PT-RS}}(l)$  is the number of subcarriers in OFDM symbol  $l$  that carries PTRS, in the PUSCH transmission;
- $Q'_{\text{ACK/CG-UCI}} = Q'_{\text{ACK}}$  if HARQ-ACK is present for transmission on the same PUSCH with UL-SCH and without CG-UCI, where  $Q'_{\text{ACK}}$  is the number of coded modulation symbols per layer for HARQ-ACK transmitted on the PUSCH as defined in clause 6.3.2.4.1.1 if number of HARQ-ACK information bits is more than 2, and  $Q'_{\text{ACK}} = 0$  if the number of HARQ-ACK information bits is 1 or 2 bits; or
- $Q'_{\text{ACK/CG-UCI}} = Q'_{\text{ACK}}$  if both HARQ-ACK and CG-UCI are present on the same PUSCH with UL-SCH, where  $Q'_{\text{ACK}}$  is the number of coded modulation symbols per layer for HARQ-ACK and CG-UCI transmitted on the PUSCH as defined in clause 6.3.2.4.1.5; or
- $Q'_{\text{ACK/CG-UCI}} = Q'_{\text{CG-UCI}}$  if CG-UCI is present on the same PUSCH with UL-SCH and without HARQ-ACK, where  $Q'_{\text{CG-UCI}}$  is the number of coded modulation symbols per layer for CG-UCI transmitted on the PUSCH as defined in clause 6.3.2.4.1.4;
- $Q'_{\text{CSI-1}}$  is the number of coded modulation symbols per layer for CSI part 1 transmitted on the PUSCH;
- $M_{\text{sc}}^{\text{UCI}}(l)$  is the number of resource elements that can be used for transmission of UCI in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{\text{symb,all}}^{\text{PUSCH}} - 1$ , in the PUSCH transmission and  $N_{\text{symb,all}}^{\text{PUSCH}}$  is the total number of OFDM symbols of the PUSCH, including all OFDM symbols used for DMRS;
  - for any OFDM symbol that carries DMRS of the PUSCH,  $M_{\text{sc}}^{\text{UCI}}(l) = 0$ ;
  - for any OFDM symbol that does not carry DMRS of the PUSCH,  $M_{\text{sc}}^{\text{UCI}}(l) = M_{\text{sc}}^{\text{PUSCH}} - M_{\text{sc}}^{\text{PT-RS}}(l)$ .
- $\alpha$  is configured by higher layer parameter *scaling*.

For CSI part 2 transmission on PUSCH not using repetition type B with UL-SCH, and if *numberOfSlotsTBoMS* is present in the resource allocation table and the value of *numberOfSlotsTBoMS* in the row indicated by the Time domain resource assignment field in DCI is larger than 1, the number of coded modulation symbols per layer for CSI part 2 transmission, denoted as  $Q'_{\text{CSI-part2}}$ , is determined as follows:

$$Q'_{\text{CSI-2}} = \min \left\{ \left\lceil \frac{(O_{\text{CSI-2}} + L_{\text{CSI-2}}) \cdot \beta_{\text{offset}}^{\text{PUSCH}} \cdot \sum_{l=0}^{N_{\text{symb,all}}^{\text{PUSCH}} - 1} M_{\text{sc}}^{\text{UCI}}(l)}{\frac{1}{N_s} \sum_{r=0}^{C_{\text{UL-SCH}} - 1} K_r} \right\rceil, \left\lceil \alpha \cdot \sum_{l=0}^{N_{\text{symb,all}}^{\text{PUSCH}} - 1} M_{\text{sc}}^{\text{UCI}}(l) \right\rceil - Q'_{\text{ACK/CG-UCI}} - Q'_{\text{CSI-1}} \right\}$$

where

- $N_s$  is the value of *numberOfSlotsTBoMS* in the row indicated by the Time domain resource assignment field in DCI;
- $M_{\text{sc}}^{\text{PT-RS}}(l)$  is the number of subcarriers in OFDM symbol  $l$  that carries PTRS, in the PUSCH transmission of TB processing over multiple slots in the slot with the CSI part 2 transmission;
- $M_{\text{sc}}^{\text{UCI}}(l)$  is the number of resource elements that can be used for transmission of UCI in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{\text{symb,all}}^{\text{PUSCH}} - 1$ , in the PUSCH transmission of TB processing over multiple slots in the slot with the CSI part 2 transmission and  $N_{\text{symb,all}}^{\text{PUSCH}}$  is the total number of OFDM symbols of the PUSCH in the slot, including all OFDM symbols used for DMRS;
- and all the other notations in the formula are defined the same as for PUSCH not using repetition type B and if *numberOfSlotsTBoMS* is not present in the resource allocation table.

For CSI part 2 transmission on an actual repetition of a PUSCH with repetition Type B with UL-SCH, the number of coded modulation symbols per layer for CSI part 2 transmission, denoted as  $Q'_{\text{CSI-part2}}$ , is determined as follows:

$$Q'_{\text{CSI-2}} = \min \left\{ \left\lceil \frac{(O_{\text{CSI-2}} + L_{\text{CSI-2}}) \cdot \beta_{\text{offset}}^{\text{PUSCH}} \cdot \sum_{l=0}^{N_{\text{symb,nominal}}^{\text{PUSCH}} - 1} M_{\text{sc,nominal}}^{\text{UCI}}(l)}{\sum_{r=0}^{C_{\text{UL-SCH}} - 1} K_r} \right\rceil, \left\lceil \alpha \cdot \sum_{l=0}^{N_{\text{symb,nominal}}^{\text{PUSCH}} - 1} M_{\text{sc,nominal}}^{\text{UCI}}(l) \right\rceil - Q'_{\text{ACK/CG-UCI}} - Q'_{\text{CSI-1}}, \sum_{l=0}^{N_{\text{symb,actual}}^{\text{PUSCH}} - 1} M_{\text{sc,actual}}^{\text{UCI}}(l) - Q'_{\text{ACK/CG-UCI}} - Q'_{\text{CSI-1}} \right\}$$

where

- $M_{\text{sc,nominal}}^{\text{UCI}}(l)$  is the number of resource elements that can be used for transmission of UCI in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{\text{symb,nominal}}^{\text{PUSCH}} - 1$ , in the PUSCH transmission assuming a nominal repetition without segmentation, and  $N_{\text{symb,nominal}}^{\text{PUSCH}}$  is the total number of OFDM symbols in a nominal repetition of the PUSCH, including all OFDM symbols used for DMRS;
- for any OFDM symbol that carries DMRS of the PUSCH assuming a nominal repetition without segmentation,  $M_{\text{sc,nominal}}^{\text{UCI}}(l) = 0$ ;
- for any OFDM symbol that does not carry DMRS of the PUSCH assuming a nominal repetition without segmentation,  $M_{\text{sc,nominal}}^{\text{UCI}}(l) = M_{\text{sc}}^{\text{PUSCH}} - M_{\text{sc,nominal}}^{\text{PT-RS}}(l)$  where  $M_{\text{sc,nominal}}^{\text{PT-RS}}(l)$  is the number of subcarriers in OFDM symbol  $l$  that carries PTRS, in the PUSCH transmission assuming a nominal repetition without segmentation;
- $M_{\text{sc,actual}}^{\text{UCI}}(l)$  is the number of resource elements that can be used for transmission of UCI in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{\text{symb,actual}}^{\text{PUSCH}} - 1$ , in the actual repetition of the PUSCH transmission, and  $N_{\text{symb,actual}}^{\text{PUSCH}}$  is the total number of OFDM symbols in the actual repetition of the PUSCH transmission, including all OFDM symbols used for DMRS;

- for any OFDM symbol that carries DMRS of the actual repetition of the PUSCH transmission,  $M_{sc,actual}^{UCI}(l) = 0$ ;
- for any OFDM symbol that does not carry DMRS of the actual repetition of the PUSCH transmission,  $M_{sc,actual}^{UCI}(l) = M_{sc}^{PUSCH} - M_{sc,actual}^{PT-RS}(l)$  where  $M_{sc,actual}^{PT-RS}(l)$  is the number of subcarriers in OFDM symbol  $l$  that carries PTRS, in the actual repetition of the PUSCH transmission;
- and all the other notations in the formula are defined the same as for PUSCH not using repetition type B and if  $numberOfSlotsTBoMS$  is not present in the resource allocation table.

For CSI part 2 transmission on PUSCH without UL-SCH, the number of coded modulation symbols per layer for CSI part 2 transmission, denoted as  $Q'_{CSI-part2}$ , is determined as follows:

$$Q'_{CSI-2} = \sum_{l=0}^{N_{\text{symb,all}}^{PUSCH}-1} M_{sc}^{UCI}(l) - Q'_{ACK} - Q'_{CSI-1}$$

where

- $M_{sc}^{PUSCH}$  is the scheduled bandwidth of the PUSCH transmission, expressed as a number of subcarriers;
- $M_{sc}^{PT-RS}(l)$  is the number of subcarriers in OFDM symbol  $l$  that carries PTRS, in the PUSCH transmission;
- $Q'_{ACK}$  is the number of coded modulation symbols per layer for HARQ-ACK transmitted on the PUSCH if number of HARQ-ACK information bits is more than 2, and  $Q'_{ACK} = 0$  if the number of HARQ-ACK information bits is 1 or 2 bits;
- $Q'_{CSI-1}$  is the number of coded modulation symbols per layer for CSI part 1 transmitted on the PUSCH;
- $M_{sc}^{UCI}(l)$  is the number of resource elements that can be used for transmission of UCI in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{\text{symb,all}}^{PUSCH} - 1$ , in the PUSCH transmission and  $N_{\text{symb,all}}^{PUSCH}$  is the total number of OFDM symbols of the PUSCH, including all OFDM symbols used for DMRS;
  - for any OFDM symbol that carries DMRS of the PUSCH,  $M_{sc}^{UCI}(l) = 0$ ;
  - for any OFDM symbol that does not carry DMRS of the PUSCH,  $M_{sc}^{UCI}(l) = M_{sc}^{PUSCH} - M_{sc}^{PT-RS}(l)$ .

The input bit sequence to rate matching is  $d_{r0}, d_{r1}, d_{r2}, d_{r3}, \dots, d_{r(N_r-1)}$  where  $r$  is the code block number, and  $N_r$  is the number of coded bits in code block number  $r$ .

Rate matching is performed according to Clause 5.4.1 by setting  $I_{BL} = 1$  and the rate matching output sequence length to  $E_r = \lfloor E_{UCI} / C_{UCI} \rfloor$ , where

- $C_{UCI}$  is the number of code blocks for UCI determined according to Clause 5.2.1;
- $N_L$  is the number of transmission layers of the PUSCH;
- $Q_m$  is the modulation order of the PUSCH;
- $E_{UCI} = N_L \cdot Q'_{CSI-2} \cdot Q_m$ .

The output bit sequence after rate matching is denoted as  $f_{r0}, f_{r1}, f_{r2}, \dots, f_{r(E_r-1)}$  where  $E_r$  is the length of rate matching output sequence in code block number  $r$ .

## 6.3.2.4.1.4 CG-UCI

For CG-UCI transmission on PUSCH with UL-SCH and if *numberOfSlotsTBoMS* is not present in the resource allocation table, or if *numberOfSlotsTBoMS* is present in the resource allocation table and the value of *numberOfSlotsTBoMS* in the row indicated by the Time domain resource assignment field in DCI is equal to 1, the number of coded modulation symbols per layer for CG-UCI transmission, denoted as  $Q'_{CG-UCI}$ , is determined as follows:

$$Q'_{CG-UCI} = \min \left\{ \left\lceil \frac{(O_{CG-UCI} + L_{CG-UCI}) \cdot \beta_{offset}^{PUSCH} \cdot \sum_{l=0}^{N_{symb,all}^{PUSCH}-1} M_{sc}^{UCI}(l)}{\sum_{r=0}^{C_{UL-SCH}-1} K_r} \right\rceil, \left\lceil \alpha \cdot \sum_{l=l_0}^{N_{symb,all}^{PUSCH}-1} M_{sc}^{UCI}(l) \right\rceil \right\}$$

where

- $O_{CG-UCI}$  is the number of CG-UCI bits;
- $L_{CG-UCI}$  is the number of CRC bits for CG-UCI determined according to Clause 6.3.1.2.1;
- $\beta_{offset}^{PUSCH} = \beta_{offset}^{CG-UCI}$ ;
- $C_{UL-SCH}$  is the number of code blocks for UL-SCH of the PUSCH transmission;
- $K_r$  is the  $r$ -th code block size for UL-SCH of the PUSCH transmission;
- $M_{sc}^{PUSCH}$  is the scheduled bandwidth of the PUSCH transmission, expressed as a number of subcarriers;
- $M_{sc}^{PT-RS}(l)$  is the number of subcarriers in OFDM symbol  $l$  that carries PTRS, in the PUSCH transmission;
- $M_{sc}^{UCI}(l)$  is the number of resource elements that can be used for transmission of UCI in OFDM symbol  $l$ , for  $l=0,1,2,\dots, N_{symb,all}^{PUSCH}-1$ , in the PUSCH transmission and  $N_{symb,all}^{PUSCH}$  is the total number of OFDM symbols of the PUSCH, including all OFDM symbols used for DMRS;
- for any OFDM symbol that carries DMRS of the PUSCH,  $M_{sc}^{UCI}(l) = 0$ ;
- for any OFDM symbol that does not carry DMRS of the PUSCH,  $M_{sc}^{UCI}(l) = M_{sc}^{PUSCH} - M_{sc}^{PT-RS}(l)$ ;
- $\alpha$  is configured by higher layer parameter *scaling*;
- $l_0$  is the symbol index of the first OFDM symbol that does not carry DMRS of the PUSCH, after the first DMRS symbol(s), in the PUSCH transmission.

For CG-UCI transmission on PUSCH with UL-SCH, and if *numberOfSlotsTBoMS* is present in the resource allocation table and the value of *numberOfSlotsTBoMS* in the row indicated by the Time domain resource assignment field in DCI is larger than 1, the number of coded modulation symbols per layer for CG-UCI transmission, denoted as  $Q'_{CG-UCI}$ , is determined as follows:

$$Q'_{CG-UCI} = \min \left\{ \left\lceil \frac{(O_{CG-UCI} + L_{CG-UCI}) \cdot \beta_{offset}^{PUSCH} \cdot \sum_{l=0}^{N_{symb,all}^{PUSCH}-1} M_{sc}^{UCI}(l)}{\frac{1}{N_s} \sum_{r=0}^{C_{UL-SCH}-1} K_r} \right\rceil, \left\lceil \alpha \cdot \sum_{l=l_0}^{N_{symb,all}^{PUSCH}-1} M_{sc}^{UCI}(l) \right\rceil \right\}$$

where

- $N_s$  is the value of *numberOfSlotsTBoMS* in the row indicated by the Time domain resource assignment field in DCI;
- $M_{sc}^{PT-RS}(l)$  is the number of subcarriers in OFDM symbol  $l$  that carries PTRS, in the PUSCH transmission of TB processing over multiple slots in the slot with the CG-UCI transmission;
- $M_{sc}^{UCI}(l)$  is the number of resource elements that can be used for transmission of UCI in OFDM symbol  $l$ , for  $l = 0,1,2, \dots, N_{symb,all}^{PUSCH}-1$ , in the PUSCH transmission of TB processing over multiple slots in the slot with the CG-UCI transmission and  $N_{symb,all}^{PUSCH}$  is the total number of OFDM symbols of the PUSCH in the slot, including all OFDM symbols used for DMRS;

- $l_0$  is the symbol index of the first OFDM symbol that does not carry DMRS of the PUSCH, after the first DMRS symbol(s), in the PUSCH transmission of TB processing over multiple slots in the slot with the CG-UCI transmission;
- and all the other notations in the formula are defined the same as for PUSCH with UL-SCH and if *numberOfSlotsTBoMS* is not present in the resource allocation table.

The input bit sequence to rate matching is  $d_{r0}, d_{r1}, d_{r2}, d_{r3}, \dots, d_{r(N_r-1)}$  where  $r$  is the code block number, and  $N_r$  is the number of coded bits in code block number  $r$ .

Rate matching is performed according to Clause 5.4.1 by setting  $I_{BL} = 1$  and the rate matching output sequence length to  $E_r = \lfloor E_{UCI} / C_{UCI} \rfloor$ , where

- $C_{UCI}$  is the number of code blocks for UCI determined according to Clause 5.2.1;
- $N_L$  is the number of transmission layers of the PUSCH;
- $Q_m$  is the modulation order of the PUSCH;
- $E_{UCI} = N_L \cdot Q'_{CG-UCI} \cdot Q_m$ .

The output bit sequence after rate matching is denoted as  $f_{r0}, f_{r1}, f_{r2}, \dots, f_{r(E_r-1)}$  where  $E_r$  is the length of rate matching output sequence in code block number  $r$ .

#### 6.3.2.4.1.5 HARQ-ACK and CG-UCI

For HARQ-ACK and CG-UCI transmission on PUSCH with UL-SCH and if *numberOfSlotsTBoMS* is not present in the resource allocation table, or if *numberOfSlotsTBoMS* is present in the resource allocation table and the value of *numberOfSlotsTBoMS* in the row indicated by the Time domain resource assignment field in DCI is equal to 1, the number of coded modulation symbols per layer for HARQ-ACK and CG-UCI transmission, denoted as  $Q'_{ACK}$ , is determined as follows:

$$Q'_{ACK} = \min \left\{ \left\lfloor \frac{(O_{ACK} + O_{CG-UCI} + L_{ACK}) \cdot \beta_{offset}^{PUSCH} \cdot \sum_{l=0}^{N_{symb,all}^{PUSCH}-1} M_{sc}^{UCI}(l)}{\sum_{r=0}^{C_{UL-SCH}-1} K_r} \right\rfloor, \left\lfloor \alpha \cdot \sum_{l=l_0}^{N_{symb,all}^{PUSCH}-1} M_{sc}^{UCI}(l) \right\rfloor \right\}$$

where

- $O_{ACK}$  is the number of HARQ-ACK bits;
- $O_{CG-UCI}$  is the number of CG-UCI bits;
- if  $O_{ACK} + O_{CG-UCI} \geq 360$ ,  $L_{ACK} = 11$ ; otherwise  $L_{ACK}$  is the number of CRC bits for HARQ-ACK and CG-UCI determined according to Clause 6.3.1.2.1;
- $\beta_{offset}^{PUSCH} = \beta_{offset}^{HARQ-ACK}$ ;
- $C_{UL-SCH}$  is the number of code blocks for UL-SCH of the PUSCH transmission;
- $K_r$  is the  $r$ -th code block size for UL-SCH of the PUSCH transmission;
- $M_{sc}^{PUSCH}$  is the scheduled bandwidth of the PUSCH transmission, expressed as a number of subcarriers;
- $M_{sc}^{PT-RS}(l)$  is the number of subcarriers in OFDM symbol  $l$  that carries PTRS, in the PUSCH transmission;
- $M_{sc}^{UCI}(l)$  is the number of resource elements that can be used for transmission of UCI in OFDM symbol  $l$ , for  $l=0,1,2,\dots, N_{symb,all}^{PUSCH}-1$ , in the PUSCH transmission and  $N_{symb,all}^{PUSCH}$  is the total number of OFDM symbols of the PUSCH, including all OFDM symbols used for DMRS;
  - for any OFDM symbol that carries DMRS of the PUSCH,  $M_{sc}^{UCI}(l) = 0$ ;
  - for any OFDM symbol that does not carry DMRS of the PUSCH,  $M_{sc}^{UCI}(l) = M_{sc}^{PUSCH} - M_{sc}^{PT-RS}(l)$ ;

- $\alpha$  is configured by higher layer parameter *scaling*;
- $l_0$  is the symbol index of the first OFDM symbol that does not carry DMRS of the PUSCH, after the first DMRS symbol(s), in the PUSCH transmission.

For HARQ-ACK and CG-UCI transmission on PUSCH with UL-SCH, and if *numberOfSlotsTBoMS* is present in the resource allocation table and the value of *numberOfSlotsTBoMS* in the row indicated by the Time domain resource assignment field in DCI is larger than 1, the number of coded modulation symbols per layer for HARQ-ACK and CG-UCI transmission, denoted as  $Q'_{ACK}$ , is determined as follows:

$$Q'_{ACK} = \min \left\{ \left\lceil \frac{(O_{ACK} + O_{CG-UCI} + L_{ACK}) \cdot \beta_{offset}^{PUSCH} \cdot \sum_{l=0}^{N_{symb,all}^{PUSCH}-1} M_{sc}^{UCI}(l)}{\frac{1}{N_s} \sum_{r=0}^{C_{UL-SCH}-1} K_r} \right\rceil, \left\lceil \alpha \cdot \sum_{l=l_0}^{N_{symb,all}^{PUSCH}-1} M_{sc}^{UCI}(l) \right\rceil \right\}$$

where

- $N_s$  is the value of *numberOfSlotsTBoMS* in the row indicated by the Time domain resource assignment field in DCI;
- $M_{sc}^{PT-RS}(l)$  is the number of subcarriers in OFDM symbol  $l$  that carries PTRS, in the PUSCH transmission of TB processing over multiple slots in the slot with the HARQ-ACK and CG-UCI transmission;
- $M_{sc}^{UCI}(l)$  is the number of resource elements that can be used for transmission of UCI in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{symb,all}^{PUSCH} - 1$ , in the PUSCH transmission of TB processing over multiple slots in the slot with the HARQ-ACK and CG-UCI transmission and  $N_{symb,all}^{PUSCH}$  is the total number of OFDM symbols of the PUSCH in the slot, including all OFDM symbols used for DMRS;
- $l_0$  is the symbol index of the first OFDM symbol that does not carry DMRS of the PUSCH, after the first DMRS symbol(s), in the PUSCH transmission of TB processing over multiple slots in the slot with the HARQ-ACK and CG-UCI transmission;
- and all the other notations in the formula are defined the same as for PUSCH with UL-SCH and if *numberOfSlotsTBoMS* is not present in the resource allocation table.

The input bit sequence to rate matching is  $d_{r0}, d_{r1}, d_{r2}, d_{r3}, \dots, d_{r(N_r-1)}$  where  $r$  is the code block number, and  $N_r$  is the number of coded bits in code block number  $r$ .

Rate matching is performed according to Clause 5.4.1 by setting  $l_{BIL} = 1$  and the rate matching output sequence length to  $E_r = \lfloor E_{UCI}/C_{UCI} \rfloor$ , where

- $C_{UCI}$  is the number of code blocks for UCI determined according to Clause 5.2.1;
- $N_L$  is the number of transmission layers of the PUSCH;
- $Q_m$  is the modulation order of the PUSCH;
- $E_{UCI} = N_L \cdot Q'_{ACK} \cdot Q_m$ .

The output bit sequence after rate matching is denoted as  $f_{r0}, f_{r1}, f_{r2}, \dots, f_{r(E_r-1)}$  where  $E_r$  is the length of rate matching output sequence in code block number  $r$ .

#### 6.3.2.4.1.6 UCI with different priority indexes

In this clause,  $\beta_{offset}^{HARQ-ACK-LP}$  is equal to  $\beta_{offset}^{HARQ-ACK,0}$  defined in [5, TS38.213] in case of PUSCH associated with priority index 1, and equal to  $\beta_{offset}^{HARQ-ACK}$  defined in [5, TS38.213] in case of PUSCH associated with priority index 0.  $\beta_{offset}^{HARQ-ACK-HP}$  is equal to  $\beta_{offset}^{HARQ-ACK,1}$  defined in [5, TS38.213] in case of PUSCH associated with priority index 0, and equal to  $\beta_{offset}^{HARQ-ACK}$  defined in [5, TS38.213] in case of PUSCH associated with priority index 1.



If *uci-MuxWithDiffPrio* is configured, and HARQ-ACK bits associated with priority index 0, and CSI part 1 if any are transmitted on a PUSCH associated with priority index 1:

- If CSI part 1 is also transmitted on the PUSCH,
  - Perform rate matching for CSI part 1 according to clause 6.3.2.4.1.2, by assuming the number of HARQ-ACK information bits to be transmitted on PUSCH in clause 6.3.2.4.1.2 is 0 bit.
  - Perform rate matching for HARQ-ACK with priority index 0 according to clause 6.3.2.4.1.3, by taking HARQ-ACK with priority index 0 as CSI part 2 and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{HARQ-ACK-LP}}$ , and assuming the number of HARQ-ACK information bits to be transmitted on PUSCH in clause 6.3.2.4.1.3 is 0 bit.
- Otherwise, perform rate matching for HARQ-ACK with priority index 0 according to clause 6.3.2.4.1.2, by taking HARQ-ACK with priority index 0 as CSI-part 1 and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{HARQ-ACK-LP}}$ , and assuming the number of HARQ-ACK information bits to be transmitted on PUSCH in clause 6.3.2.4.1.2 is 0 bit.

If *uci-MuxWithDiffPrio* is configured, and HARQ-ACK bits associated with priority index 1, and CSI if any are transmitted on a PUSCH associated with priority index 0:

- Perform rate matching for HARQ-ACK with priority index 1 according to clause 6.3.2.4.1.1, by taking HARQ-ACK with priority index 1 as HARQ-ACK and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{HARQ-ACK-HP}}$ .
- Perform rate matching for CSI part 1 according to clause 6.3.2.4.1.2, by taking HARQ-ACK with priority index 1 as HARQ-ACK, if CSI part 1 is also transmitted on the PUSCH.
- Perform rate matching for CSI part 2 according to clause 6.3.2.4.1.3, by taking HARQ-ACK with priority index 1 as HARQ-ACK, if CSI part 2 is also transmitted on the PUSCH.

If *uci-MuxWithDiffPrio* is configured, and HARQ-ACK bits associated with priority index 0, HARQ-ACK bits associated with priority index 1 and/or CG-UCI associated with priority index 1, and CSI part 1 if any are transmitted on a PUSCH:

- Perform rate matching for HARQ-ACK with priority index 1 according to clause 6.3.2.4.1.1, by taking HARQ-ACK with priority index 1 as HARQ-ACK and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{HARQ-ACK-HP}}$ , if HARQ-ACK bits associated with priority index 1 are transmitted without CG-UCI associated with priority index 1.
- Perform rate matching for CG-UCI with priority index 1 according to clause 6.3.2.4.1.4, if CG-UCI associated with priority index 1 is transmitted without HARQ-ACK bits associated with priority index 1.
- Perform rate matching for CG-UCI with priority index 1 and HARQ-ACK with priority index 1 according to clause 6.3.2.4.1.5, if both CG-UCI associated with priority index 1 and HARQ-ACK bits associated with priority index 1 are transmitted, by taking HARQ-ACK with priority index 1 as HARQ-ACK and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{HARQ-ACK-HP}}$ .
- If CSI part 1 is also transmitted on the PUSCH and the PUSCH is associated with priority index 1,
  - Perform rate matching for CSI part 1 according to clause 6.3.2.4.1.2, by taking HARQ-ACK with priority index 1 if any as HARQ-ACK, and taking CG-UCI associated with priority index 1 if any as CG-UCI.
  - Perform rate matching for HARQ-ACK with priority index 0 according to clause 6.3.2.4.1.3, by taking HARQ-ACK with priority index 0 as CSI part 2 and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{HARQ-ACK-LP}}$ , and taking HARQ-ACK with priority index 1 if any as HARQ-ACK, and taking CG-UCI associated with priority index 1 if any as CG-UCI.
- Otherwise,
  - Perform rate matching for HARQ-ACK with priority index 0 according to clause 6.3.2.4.1.2, by taking HARQ-ACK with priority index 0 as CSI-part 1 and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{HARQ-ACK-LP}}$ , and taking HARQ-ACK with priority index 1 if any as HARQ-ACK, and taking CG-UCI associated with priority index 1 if any as CG-UCI.
  - Perform rate matching for CSI part 1 according to clause 6.3.2.4.1.3, by taking CSI part 1 as CSI part 2 and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{CSI-part1}}$ , taking HARQ-ACK with priority index 0 as CSI-part 1 and taking HARQ-

ACK with priority index 1 as HARQ-ACK, if CSI part 1 is also transmitted on the PUSCH and the PUSCH is associated with priority index 0.

If *uci-MuxWithDiffPrio* is configured, and CG-UCI associated with priority index 0 and HARQ-ACK bits associated with priority index 0 if any, HARQ-ACK bits associated with priority index 1, and CSI part 1 if any are transmitted on a PUSCH associated with priority index 0:

- Perform rate matching for HARQ-ACK with priority index 1 according to clause 6.3.2.4.1.1, by taking HARQ-ACK with priority index 1 as HARQ-ACK and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{HARQ-ACK-HP}}$ .
- Perform rate matching for CG-UCI associated with priority index 0 according to clause 6.3.2.4.1.2, if CG-UCI associated with priority index 0 is transmitted without HARQ-ACK bits associated with priority index 0, by taking CG-UCI associated with priority index 0 as CSI-part 1 and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{CG-UCI}}$ , and taking HARQ-ACK with priority index 1 as HARQ-ACK.
- Perform rate matching for CG-UCI associated with priority index 0 and HARQ-ACK bits associated with priority index 0 according to clause 6.3.2.4.1.2, if both CG-UCI associated with priority index 0 and HARQ-ACK bits associated with priority index 0 are transmitted, by taking CG-UCI associated with priority index 0 and HARQ-ACK bits associated with priority index 0 as CSI-part 1 and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{HARQ-ACK-LP}}$ , and taking HARQ-ACK with priority index 1 as HARQ-ACK.
- Perform rate matching for CSI part 1 according to clause 6.3.2.4.1.3, by taking CSI part 1 as CSI part 2 and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{CSI-part1}}$ , taking CG-UCI associated with priority index 0 and HARQ-ACK bits associated with priority index 0 if any as CSI-part 1 and taking HARQ-ACK with priority index 1 as HARQ-ACK, if CSI part 1 is also transmitted on the PUSCH and the PUSCH is associated with priority index 0.

#### 6.3.2.4.2 UCI encoded by channel coding of small block lengths

##### 6.3.2.4.2.1 HARQ-ACK

For HARQ-ACK transmission on PUSCH, the number of coded modulation symbols per layer for HARQ-ACK transmission, denoted as  $Q'_{\text{ACK}}$ , is determined according to Clause 6.3.2.4.1.1, by setting the number of CRC bits  $L = 0$ .

The input bit sequence to rate matching is  $d_0, d_1, d_2, \dots, d_{N-1}$ .

Rate matching is performed according to Clause 5.4.3, by setting the rate matching output sequence length  $E = N_L \cdot Q'_{\text{ACK}} \cdot Q_m$ , where

- $N_L$  is the number of transmission layers of the PUSCH;
- $Q_m$  is the modulation order of the PUSCH.

The output bit sequence after rate matching is denoted as  $f_0, f_1, f_2, \dots, f_{E-1}$ .

##### 6.3.2.4.2.2 CSI part 1

For CSI part 1 transmission on PUSCH, the number of coded modulation symbols per layer for CSI part 1 transmission, denoted as  $Q'_{\text{CSI,1}}$ , is determined according to Clause 6.3.2.4.1.2, by setting the number of CRC bits  $L = 0$ .

Rate matching is performed according to Clause 5.4.3, by setting the rate matching output sequence length  $E = N_L \cdot Q'_{\text{CSI,1}} \cdot Q_m$ , where

- $N_L$  is the number of transmission layers of the PUSCH;
- $Q_m$  is the modulation order of the PUSCH.

The output bit sequence after rate matching is denoted as  $f_0, f_1, f_2, \dots, f_{E-1}$ .

#### 6.3.2.4.2.3 CSI part 2

For CSI part 2 transmission on PUSCH, the number of coded modulation symbols per layer for CSI part 2 transmission, denoted as  $Q'_{\text{CSI},2}$ , is determined according to Clause 6.3.2.4.1.3, by setting the number of CRC bits  $L = 0$ .

Rate matching is performed according to Clause 5.4.3, by setting the rate matching output sequence length  $E = N_L \cdot Q'_{\text{CSI},2} \cdot Q_m$ , where

- $N_L$  is the number of transmission layers of the PUSCH;
- $Q_m$  is the modulation order of the PUSCH.

The output bit sequence after rate matching is denoted as  $f_0, f_1, f_2, \dots, f_{E-1}$ .

#### 6.3.2.4.2.4 CG-UCI

For CG-UCI transmission on PUSCH, the number of coded modulation symbols per layer for CG-UCI transmission, denoted as  $Q'_{\text{CG-UCI}}$ , is determined according to Clause 6.3.2.4.1.4, by setting the number of CRC bits  $L_{\text{CG-UCI}} = 0$ .

The input bit sequence to rate matching is  $d_0, d_1, d_2, \dots, d_{N-1}$ .

Rate matching is performed according to Clause 5.4.3, by setting the rate matching output sequence length

$E = N_L \cdot Q'_{\text{CG-UCI}} \cdot Q_m$ , where

- $N_L$  is the number of transmission layers of the PUSCH;
- $Q_m$  is the modulation order of the PUSCH.

The output bit sequence after rate matching is denoted as  $f_0, f_1, f_2, \dots, f_{E-1}$ .

#### 6.3.2.4.2.5 HARQ-ACK and CG-UCI

For HARQ-ACK and CG-UCI transmission on PUSCH, the number of coded modulation symbols per layer for HARQ-ACK and CG-UCI transmission, denoted as  $Q'_{\text{ACK}}$ , is determined according to Clause 6.3.2.4.1.5, by setting the number of CRC bits  $L_{\text{ACK}} = 0$ .

The input bit sequence to rate matching is  $d_0, d_1, d_2, \dots, d_{N-1}$ .

Rate matching is performed according to Clause 5.4.3, by setting the rate matching output sequence length  $E = N_L \cdot Q'_{\text{ACK}} \cdot Q_m$ , where

- $N_L$  is the number of transmission layers of the PUSCH;
- $Q_m$  is the modulation order of the PUSCH.

The output bit sequence after rate matching is denoted as  $f_0, f_1, f_2, \dots, f_{E-1}$ .

#### 6.3.2.4.2.6 UCI with different priority indexes

In this clause,  $\beta_{\text{offset}}^{\text{HARQ-ACK-LP}}$  is equal to  $\beta_{\text{offset}}^{\text{HARQ-ACK},0}$  defined in [5, TS38.213] in case of PUSCH associated with priority index 1, and equal to  $\beta_{\text{offset}}^{\text{HARQ-ACK}}$  defined in [5, TS38.213] in case of PUSCH associated with priority index 0.  $\beta_{\text{offset}}^{\text{HARQ-ACK-HP}}$  is equal to  $\beta_{\text{offset}}^{\text{HARQ-ACK},1}$  defined in [5, TS38.213] in case of PUSCH associated with priority index 0, and equal to  $\beta_{\text{offset}}^{\text{HARQ-ACK}}$  defined in [5, TS38.213] in case of PUSCH associated with priority index 1.

If *uci-MuxWithDiffPrio* is configured, and HARQ-ACK bits associated with priority index 0, and CSI part 1 if any are transmitted on a PUSCH associated with priority index 1:

- If CSI part 1 is also transmitted on the PUSCH,
- Perform rate matching for CSI part 1 according to clause 6.3.2.4.2.2, by assuming the number of HARQ-ACK information bits to be transmitted on PUSCH in clause 6.3.2.4.2.2 is 0 bit.

- Perform rate matching for HARQ-ACK with priority index 0 according to clause 6.3.2.4.2.3, by taking HARQ-ACK with priority index 0 as CSI part 2 and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{HARQ-ACK-LP}}$ , and assuming the number of HARQ-ACK information bits to be transmitted on PUSCH in clause 6.3.2.4.2.3 is 0 bit.
- Otherwise, perform rate matching for HARQ-ACK with priority index 0 according to clause 6.3.2.4.2.2, by taking HARQ-ACK with priority index 0 as CSI-part 1 and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{HARQ-ACK-LP}}$ , and assuming the number of HARQ-ACK information bits to be transmitted on PUSCH in clause 6.3.2.4.2.2 is 0 bit.

If *uci-MuxWithDiffPrio* is configured, and HARQ-ACK bits associated with priority index 1, and CSI if any are transmitted on a PUSCH associated with priority index 0:

- Perform rate matching for HARQ-ACK with priority index 1 according to clause 6.3.2.4.2.1, by taking HARQ-ACK with priority index 1 as HARQ-ACK and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{HARQ-ACK-HP}}$ .
- Perform rate matching for CSI part 1 according to clause 6.3.2.4.2.2, by taking HARQ-ACK with priority index 1 as HARQ-ACK, if CSI part 1 is also transmitted on the PUSCH.
- Perform rate matching for CSI part 2 according to clause 6.3.2.4.2.3, by taking HARQ-ACK with priority index 1 as HARQ-ACK, if CSI part 2 is also transmitted on the PUSCH.

If *uci-MuxWithDiffPrio* is configured, and HARQ-ACK bits associated with priority index 0, HARQ-ACK bits associated with priority index 1 and/or CG-UCI associated with priority index 1, and CSI part 1 if any are transmitted on a PUSCH:

- Perform rate matching for HARQ-ACK with priority index 1 according to clause 6.3.2.4.2.1, by taking HARQ-ACK with priority index 1 as HARQ-ACK and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{HARQ-ACK-HP}}$ , if HARQ-ACK bits associated with priority index 1 are transmitted without CG-UCI associated with priority index 1.
- Perform rate matching for CG-UCI with priority index 1 according to clause 6.3.2.4.2.4, if CG-UCI associated with priority index 1 is transmitted without HARQ-ACK bits associated with priority index 1.
- Perform rate matching for CG-UCI with priority index 1 and HARQ-ACK with priority index 1 according to clause 6.3.2.4.2.5, if both CG-UCI associated with priority index 1 and HARQ-ACK bits associated with priority index 1 are transmitted, by taking HARQ-ACK with priority index 1 as HARQ-ACK and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{HARQ-ACK-HP}}$ .
- If CSI part 1 is also transmitted on the PUSCH and the PUSCH is associated with priority index 1,
  - Perform rate matching for CSI part 1 according to clause 6.3.2.4.2.2, by taking HARQ-ACK with priority index 1 if any as HARQ-ACK, and taking CG-UCI associated with priority index 1 if any as CG-UCI.
  - Perform rate matching for HARQ-ACK with priority index 0 according to clause 6.3.2.4.2.3, by taking HARQ-ACK with priority index 0 as CSI part 2 and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{HARQ-ACK-LP}}$ , and taking HARQ-ACK with priority index 1 if any as HARQ-ACK, and taking CG-UCI associated with priority index 1 if any as CG-UCI.
- Otherwise,
  - Perform rate matching for HARQ-ACK with priority index 0 according to clause 6.3.2.4.2.2, by taking HARQ-ACK with priority index 0 as CSI-part 1 and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{HARQ-ACK-LP}}$ , and taking HARQ-ACK with priority index 1 if any as HARQ-ACK, and taking CG-UCI associated with priority index 1 if any as CG-UCI.
  - Perform rate matching for CSI part 1 according to clause 6.3.2.4.2.3, by taking CSI part 1 as CSI part 2 and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{CSI-part1}}$ , taking HARQ-ACK with priority index 0 as CSI-part 1 and taking HARQ-ACK with priority index 1 as HARQ-ACK, if CSI part 1 is also transmitted on the PUSCH and the PUSCH is associated with priority index 0.

If *uci-MuxWithDiffPrio* is configured, and CG-UCI associated with priority index 0 and HARQ-ACK bits associated with priority index 0 if any, HARQ-ACK bits associated with priority index 1, and CSI part 1 if any are transmitted on a PUSCH associated with priority index 0:

- Perform rate matching for HARQ-ACK with priority index 1 according to clause 6.3.2.4.2.1, by taking HARQ-ACK with priority index 1 as HARQ-ACK and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{HARQ-ACK-HP}}$ .
- Perform rate matching for CG-UCI associated with priority index 0 according to clause 6.3.2.4.2.2, if CG-UCI associated with priority index 0 is transmitted without HARQ-ACK bits associated with priority index 0, by taking CG-UCI associated with priority index 0 as CSI-part 1 and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{CG-UCI}}$ , and taking HARQ-ACK with priority index 1 as HARQ-ACK.
- Perform rate matching for CG-UCI associated with priority index 0 and HARQ-ACK bits associated with priority index 0 according to clause 6.3.2.4.2.2, if both CG-UCI associated with priority index 0 and HARQ-ACK bits associated with priority index 0 are transmitted, by taking CG-UCI associated with priority index 0 and HARQ-ACK bits associated with priority index 0 as CSI-part 1 and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{HARQ-ACK-LP}}$ , and taking HARQ-ACK with priority index 1 as HARQ-ACK.
- Perform rate matching for CSI part 1 according to clause 6.3.2.4.2.3, by taking CSI part 1 as CSI part 2 and replacing  $\beta_{\text{offset}}^{\text{PUSCH}}$  by  $\beta_{\text{offset}}^{\text{CSI-part1}}$ , taking CG-UCI associated with priority index 0 and HARQ-ACK bits associated with priority index 0 if any as CSI-part 1 and taking HARQ-ACK with priority index 1 as HARQ-ACK, if CSI part 1 is also transmitted on the PUSCH and the PUSCH is associated with priority index 0.

### 6.3.2.5 Code block concatenation

Code block concatenation is performed according to Clause 6.3.1.5, except that the values of  $E_{\text{UCI}}$  and  $C_{\text{UCI}}$  given in Clause 6.3.2.4.1.

### 6.3.2.6 Multiplexing of coded UCI bits to PUSCH

The coded UCI bits are multiplexed onto PUSCH according to the procedures in Clause 6.2.7.

### 6.3.2.7 Multiplexing of coded UCI bits with different priority indexes to PUSCH

If *uci-MuxWithDiffPrio* is configured, and HARQ-ACK bits associated with priority index 0, and CSI part 1 if any are transmitted on a PUSCH associated with priority index 1,

- If CSI part 1 is also transmitted on the PUSCH, the coded UCI bits are multiplexed onto PUSCH according to the procedures in Clause 6.2.7 by taking HARQ-ACK with priority index 0 as CSI part 2, and assuming the number of HARQ-ACK information in Clause 6.2.7 is 0 bit;
- Otherwise, the coded UCI bits are multiplexed onto PUSCH according to the procedures in Clause 6.2.7 by taking HARQ-ACK with priority index 0 as CSI-part 1, and assuming the number of HARQ-ACK information in Clause 6.2.7 is 0 bit.

If *uci-MuxWithDiffPrio* is configured, and HARQ-ACK bits associated with priority index 1, and CSI if any are transmitted on a PUSCH associated with priority index 0, the coded UCI bits are multiplexed onto PUSCH according to the procedures in Clause 6.2.7 by taking HARQ-ACK with priority index 1 as HARQ-ACK.

If *uci-MuxWithDiffPrio* is configured, and HARQ-ACK bits associated with priority index 0, HARQ-ACK bits associated with priority index 1 and/or CG-UCI associated with priority index 1, and CSI part 1 if any are transmitted on a PUSCH,

- if CSI part 1 is also transmitted on the PUSCH and the PUSCH is associated with priority index 1, the coded UCI bits are multiplexed onto PUSCH according to the procedures in Clause 6.2.7 by taking HARQ-ACK with priority index 1 as HARQ-ACK, and taking HARQ-ACK with priority index 0 as CSI part 2;
- otherwise, the coded UCI bits are multiplexed onto PUSCH according to the procedures in Clause 6.2.7 by taking HARQ-ACK with priority index 1 if any as HARQ-ACK, taking CG-UCI associated with priority index 1 if any as CG-UCI, taking HARQ-ACK with priority index 0 as CSI part 1, and taking CSI part 1 as CSI part 2 if CSI part 1 is also transmitted on the PUSCH and the PUSCH is associated with priority index 0.

If *uci-MuxWithDiffPrio* is configured, and CG-UCI associated with priority index 0 and HARQ-ACK bits associated with priority index 0 if any, HARQ-ACK bits associated with priority index 1, and CSI part 1 if any are transmitted on a PUSCH associated with priority index 0, the coded UCI bits are multiplexed onto PUSCH according to the procedures in Clause 6.2.7 by taking HARQ-ACK with priority index 1 as HARQ-ACK, taking CG-UCI associated with priority

index 0 and HARQ-ACK bits associated with priority index 0 if any as CSI part 1, and taking CSI part 1 as CSI part 2 if CSI part 1 is also transmitted on the PUSCH and the PUSCH is associated with priority index 0.

## 7 Downlink transport channels and control information

### 7.1 Broadcast channel

Data arrives to the coding unit in the form of a maximum of one transport block every 80ms. The following coding steps can be identified:

- Payload generation
- Scrambling
- Transport block CRC attachment
- Channel coding
- Rate matching

#### 7.1.1 PBCH payload generation

Denote the bits in a transport block delivered to layer 1 by  $\bar{a}_0, \bar{a}_1, \bar{a}_2, \bar{a}_3, \dots, \bar{a}_{\bar{A}-1}$ , where  $\bar{A}$  is the payload size generated by higher layers. The lowest order information bit  $\bar{a}_0$  is mapped to the most significant bit of the transport block as defined in Clause 6.1.1 of [8, TS 38.321].

Generate the following additional timing related PBCH payload bits  $\bar{a}_{\bar{A}}, \bar{a}_{\bar{A}+1}, \bar{a}_{\bar{A}+2}, \bar{a}_{\bar{A}+3}, \dots, \bar{a}_{\bar{A}+7}$ , where:

- $\bar{a}_{\bar{A}}, \bar{a}_{\bar{A}+1}, \bar{a}_{\bar{A}+2}, \bar{a}_{\bar{A}+3}$  are the 4<sup>th</sup>, 3<sup>rd</sup>, 2<sup>nd</sup>, and 1<sup>st</sup> LSB of SFN, respectively;
- $\bar{a}_{\bar{A}+4}$  is the half frame bit  $\bar{a}_{\text{HRF}}$ ;
- if  $\bar{L}_{\text{max}} = 10$  as defined in Clause 4.1 of [5, TS38.213],  
 $\bar{a}_{\bar{A}+5}$  is the MSB of  $k_{\text{SSB}}$  as defined in Clause 7.4.3.1 of [4, TS 38.211].  
 $\bar{a}_{\bar{A}+6}$  is reserved.  
 $\bar{a}_{\bar{A}+7}$  is the MSB of candidate SS/PBCH block index.
- else if  $\bar{L}_{\text{max}} = 20$  as defined in Clause 4.1 of [5, TS38.213],  
 $\bar{a}_{\bar{A}+5}$  is the MSB of  $k_{\text{SSB}}$  as defined in Clause 7.4.3.1 of [4, TS 38.211].  
 $\bar{a}_{\bar{A}+6}, \bar{a}_{\bar{A}+7}$  are the 5<sup>th</sup> and 4<sup>th</sup> bits of the candidate SS/PBCH block index, respectively.
- else if  $\bar{L}_{\text{max}} = 64$  as defined in Clause 4.1 of [5, TS38.213],  
 $\bar{a}_{\bar{A}+5}, \bar{a}_{\bar{A}+6}, \bar{a}_{\bar{A}+7}$  are the 6<sup>th</sup>, 5<sup>th</sup>, and 4<sup>th</sup> bits of the candidate SS/PBCH block index, respectively.
- else  
 $\bar{a}_{\bar{A}+5}$  is the MSB of  $k_{\text{SSB}}$  as defined in Clause 7.4.3.1 of [4, TS 38.211].  
 $\bar{a}_{\bar{A}+6}, \bar{a}_{\bar{A}+7}$  are reserved.
- end if

Let  $A = \bar{A} + 8$ ;  $j_{\text{SFN}} = 0$ ;  $j_{\text{HRF}} = 10$ ;  $j_{\text{SSB}} = 11$ ;  $j_{\text{other}} = 14$ ;

for  $i = 0$  to  $A-1$

if  $\bar{a}_i$  is an SFN bit

$$a_{G(j_{\text{SFN}})} = \bar{a}_i;$$

$$j_{\text{SFN}} = j_{\text{SFN}} + 1;$$

elseif  $\bar{a}_i$  is the half radio frame bit

$$a_{G(j_{\text{HRF}})} = \bar{a}_i$$

elseif  $\bar{A} + 5 \leq i \leq \bar{A} + 7$

$$a_{G(j_{\text{SSB}})} = \bar{a}_i;$$

$$j_{\text{SSB}} = j_{\text{SSB}} + 1;$$

else

$$a_{G(j_{\text{Other}})} = \bar{a}_i;$$

$$j_{\text{Other}} = j_{\text{Other}} + 1;$$

end if

end for

where  $\bar{L}_{\text{max}}$  is the number of candidate SS/PBCH blocks in a half frame according to Clause 4.1 of [5, TS38.213], and the value of  $G(j)$  is given by Table 7.1.1-1.

**Table 7.1.1-1: Value of PBCH payload interleaver pattern  $G(j)$**

| $j$ | $G(j)$ | $j$ | $G(j)$ | $j$ | $G(j)$ | $j$ | $G(j)$ | $j$ | $G(j)$ | $j$ | $G(j)$ | $j$ | $G(j)$ | $j$ | $G(j)$ |
|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|
| 0   | 16     | 4   | 8      | 8   | 24     | 12  | 3      | 16  | 9      | 20  | 14     | 24  | 21     | 28  | 27     |
| 1   | 23     | 5   | 30     | 9   | 7      | 13  | 2      | 17  | 11     | 21  | 15     | 25  | 22     | 29  | 28     |
| 2   | 18     | 6   | 10     | 10  | 0      | 14  | 1      | 18  | 12     | 22  | 19     | 26  | 25     | 30  | 29     |
| 3   | 17     | 7   | 6      | 11  | 5      | 15  | 4      | 19  | 13     | 23  | 20     | 27  | 26     | 31  | 31     |

## 7.1.2 Scrambling

For PBCH transmission in a frame, the bit sequence  $a_0, a_1, a_2, a_3, \dots, a_{A-1}$  is scrambled into a bit sequence

$a'_0, a'_1, a'_2, a'_3, \dots, a'_{A-1}$ , where  $a'_i = (a_i + s_i) \bmod 2$  for  $i=0,1,\dots,A-1$  and  $s_0, s_1, s_2, s_3, \dots, s_{A-1}$  is generated according to the following:

$i = 0$ ;

$j = 0$ ;

while  $i < A$

if  $a_i$  corresponds to any one of the bits belonging to the candidate SS/PBCH block index, the half frame index, and 2<sup>nd</sup> and 3<sup>rd</sup> least significant bits of the system frame number

$$s_i = 0;$$

else

$$s_i = c(j + vM);$$

$$j = j + 1;$$

end if

$$i = i + 1;$$

end while

The scrambling sequence  $c(i)$  is given by Clause 5.2.1 of [4, TS38.211] and initialized with  $c_{\text{init}} = N_{\text{ID}}^{\text{cell}}$  at the start of each SFN satisfying  $\text{mod}(\text{SFN}, 8) = 0$ ;  $M = A - 3$  for  $\bar{L}_{\text{max}} = 4$  or  $\bar{L}_{\text{max}} = 8$ ,  $M = A - 4$  for  $\bar{L}_{\text{max}} = 10$ ,  $M = A - 5$  for  $\bar{L}_{\text{max}} = 20$ , and  $M = A - 6$  for  $\bar{L}_{\text{max}} = 64$ , where  $\bar{L}_{\text{max}}$  is the number of candidate SS/PBCH blocks in a half frame according to Clause 4.1 of [5, TS38.213]; and  $v$  is determined according to Table 7.1.2-1 using the 3<sup>rd</sup> and 2<sup>nd</sup> LSB of the SFN in which the PBCH is transmitted.

**Table 7.1.2-1: Value of  $v$  for PBCH scrambling**

| (3 <sup>rd</sup> LSB of SFN, 2 <sup>nd</sup> LSB of SFN) | Value of $v$ |
|----------------------------------------------------------|--------------|
| (0, 0)                                                   | 0            |
| (0, 1)                                                   | 1            |
| (1, 0)                                                   | 2            |
| (1, 1)                                                   | 3            |

### 7.1.3 Transport block CRC attachment

Error detection is provided on BCH transport blocks through a Cyclic Redundancy Check (CRC).

The entire transport block is used to calculate the CRC parity bits. The input bit sequence is denoted by  $a'_0, a'_1, a'_2, a'_3, \dots, a'_{A-1}$ , and the parity bits by  $p_0, p_1, p_2, p_3, \dots, p_{L-1}$ , where  $A$  is the payload size and  $L$  is the number of parity bits.

The parity bits are computed and attached to the BCH transport block according to Clause 5.1 by setting  $L$  to 24 bits and using the generator polynomial  $g_{\text{CRC24C}}(D)$ , resulting in the sequence  $b_0, b_1, b_2, b_3, \dots, b_{B-1}$ , where  $B = A + L$ .

The bit sequence  $b_0, b_1, b_2, b_3, \dots, b_{B-1}$  is the input bit sequence  $c_0, c_1, c_2, c_3, \dots, c_{K-1}$  to the channel encoder, where  $c_i = b_i$  for  $i = 0, 1, \dots, B-1$  and  $K = B$ .

### 7.1.4 Channel coding

Information bits are delivered to the channel coding block. They are denoted by  $c_0, c_1, c_2, c_3, \dots, c_{K-1}$ , where  $K$  is the number of bits, and they are encoded via Polar coding according to Clause 5.3.1, by setting  $n_{\text{max}} = 9$ ,  $I_{\text{IL}} = 1$ ,  $n_{\text{PC}} = 0$ , and  $n_{\text{PC}}^{\text{wm}} = 0$ .

After encoding the bits are denoted by  $d_0, d_1, d_2, d_3, \dots, d_{N-1}$ , where  $N$  is the number of coded bits.

### 7.1.5 Rate matching

The input bit sequence to rate matching is  $d_0, d_1, d_2, \dots, d_{N-1}$ .

The rate matching output sequence length  $E = 864$ .



Rate matching is performed according to Clause 5.4.1 by setting  $I_{BL} = 0$ .

The output bit sequence after rate matching is denoted as  $f_0, f_1, f_2, \dots, f_{E-1}$ .

## 7.2 Downlink shared channel and paging channel

### 7.2.1 Transport block CRC attachment

Error detection is provided on each transport block through a Cyclic Redundancy Check (CRC).

The entire transport block is used to calculate the CRC parity bits. Denote the bits in a transport block delivered to layer 1 by  $a_0, a_1, a_2, a_3, \dots, a_{A-1}$ , and the parity bits by  $p_0, p_1, p_2, p_3, \dots, p_{L-1}$ , where  $A$  is the payload size and  $L$  is the number of parity bits. The lowest order information bit  $a_0$  is mapped to the most significant bit of the transport block as defined in Clause 6.1.1 of [TS38.321].

The parity bits are computed and attached to the DL-SCH transport block according to Clause 5.1, by setting  $L$  to 24 bits and using the generator polynomial  $g_{CRC24A}(D)$  if  $A > 3824$ ; and by setting  $L$  to 16 bits and using the generator polynomial  $g_{CRC16}(D)$  otherwise.

The bits after CRC attachment are denoted by  $b_0, b_1, b_2, b_3, \dots, b_{B-1}$ , where  $B = A + L$ .

### 7.2.2 LDPC base graph selection

For initial transmission of a transport block with coding rate  $R$  indicated by the MCS index according to Clause 5.1.3.1 in [6, TS 38.214] and subsequent re-transmission of the same transport block, each code block of the transport block is encoded with either LDPC base graph 1 or 2 according to the following:

- if  $A \leq 292$ , or if  $A \leq 3824$  and  $R \leq 0.67$ , or if  $R \leq 0.25$ , LDPC base graph 2 is used;
- otherwise, LDPC base graph 1 is used,

where  $A$  is the payload size in Clause 7.2.1.

### 7.2.3 Code block segmentation and code block CRC attachment

The bits input to the code block segmentation are denoted by  $b_0, b_1, b_2, b_3, \dots, b_{B-1}$  where  $B$  is the number of bits in the transport block (including CRC).

Code block segmentation and code block CRC attachment are performed according to Clause 5.2.2.

The bits after code block segmentation are denoted by  $c_{r0}, c_{r1}, c_{r2}, c_{r3}, \dots, c_{r(K_r-1)}$ , where  $r$  is the code block number and  $K_r$  is the number of bits for code block number  $r$  according to Clause 5.2.2.

### 7.2.4 Channel coding

Code blocks are delivered to the channel coding block. The bits in a code block are denoted by  $c_{r0}, c_{r1}, c_{r2}, c_{r3}, \dots, c_{r(K_r-1)}$ , where  $r$  is the code block number, and  $K_r$  is the number of bits in code block number  $r$ . The total number of code blocks is denoted by  $C$  and each code block is individually LDPC encoded according to Clause 5.3.2.

After encoding the bits are denoted by  $d_{r0}, d_{r1}, d_{r2}, d_{r3}, \dots, d_{r(N_r-1)}$ , where the values of  $N_r$  is given in Clause 5.3.2.

## 7.2.5 Rate matching

Coded bits for each code block, denoted as  $d_{r0}, d_{r1}, d_{r2}, d_{r3}, \dots, d_{r(N_r-1)}$ , are delivered to the rate match block, where  $r$  is the code block number, and  $N_r$  is the number of encoded bits in code block number  $r$ . The total number of code blocks is denoted by  $C$  and each code block is individually rate matched according to Clause 5.4.2 by setting  $I_{LBRM} = 1$ .

After rate matching, the bits are denoted by  $f_{r0}, f_{r1}, f_{r2}, f_{r3}, \dots, f_{r(E_r-1)}$ , where  $E_r$  is the number of rate matched bits for code block number  $r$ .

## 7.2.6 Code block concatenation

The input bit sequence for the code block concatenation block are the sequences  $f_{r0}, f_{r1}, f_{r2}, f_{r3}, \dots, f_{r(E_r-1)}$ , for  $r = 0, \dots, C-1$  and where  $E_r$  is the number of rate matched bits for the  $r$ -th code block.

Code block concatenation is performed according to Clause 5.5.

The bits after code block concatenation are denoted by  $g_0, g_1, g_2, g_3, \dots, g_{G-1}$ , where  $G$  is the total number of coded bits for transmission.

## 7.3 Downlink control information

A DCI transports downlink control information for one or more cells with one RNTI.

The following coding steps can be identified:

- Information element multiplexing
- CRC attachment
- Channel coding
- Rate matching

### 7.3.1 DCI formats

The DCI formats defined in table 7.3.1-1 are supported.

Table 7.3.1-1: DCI formats

| DCI format | Usage                                                                                                                            |
|------------|----------------------------------------------------------------------------------------------------------------------------------|
| 0_0        | Scheduling of PUSCH in one cell                                                                                                  |
| 0_1        | Scheduling of one or multiple PUSCH in one cell, or indicating downlink feedback information for configured grant PUSCH (CG-DFI) |
| 0_2        | Scheduling of PUSCH in one cell                                                                                                  |
| 1_0        | Scheduling of PDSCH in one cell                                                                                                  |
| 1_1        | Scheduling of one or multiple PDSCH in one cell, and/or triggering one shot HARQ-ACK codebook feedback                           |
| 1_2        | Scheduling of PDSCH in one cell                                                                                                  |
| 2_0        | Notifying a group of UEs of the slot format, available RB sets, COT duration and search space set group switching                |
| 2_1        | Notifying a group of UEs of the PRB(s) and OFDM symbol(s) where UE may assume no transmission is intended for the UE             |
| 2_2        | Transmission of TPC commands for PUCCH and PUSCH                                                                                 |
| 2_3        | Transmission of a group of TPC commands for SRS transmissions by one or more UEs                                                 |
| 2_4        | Notifying a group of UEs of the PRB(s) and OFDM symbol(s) where UE cancels the corresponding UL transmission from the UE         |
| 2_5        | Notifying the availability of soft resources as defined in Clause 9.3.1 of [10, TS 38.473]                                       |
| 2_6        | Notifying the power saving information outside DRX Active Time for one or more UEs                                               |
| 2_7        | Notifying paging early indication and TRS availability indication for one or more UEs.                                           |
| 3_0        | Scheduling of NR sidelink in one cell                                                                                            |
| 3_1        | Scheduling of LTE sidelink in one cell                                                                                           |
| 4_0        | Scheduling of PDSCH with CRC scrambled by MCCH-RNTI/G-RNTI for broadcast                                                         |
| 4_1        | Scheduling of PDSCH with CRC scrambled by G-RNTI/G-CS-RNTI for multicast                                                         |
| 4_2        | Scheduling of PDSCH with CRC scrambled by G-RNTI/G-CS-RNTI for multicast                                                         |

The fields defined in the DCI formats below are mapped to the information bits  $a_0$  to  $a_{A-1}$  as follows.

Each field is mapped in the order in which it appears in the description, including the zero-padding bit(s), if any, with the first field mapped to the lowest order information bit  $a_0$  and each successive field mapped to higher order information bits. The most significant bit of each field is mapped to the lowest order information bit for that field, e.g. the most significant bit of the first field is mapped to  $a_0$ .

If the number of information bits in a DCI format is less than 12 bits, zeros shall be appended to the DCI format until the payload size equals 12.

The size of each DCI format is determined by the configuration of the corresponding active bandwidth part of the scheduled cell and shall be adjusted as described in clause 7.3.1.0 if necessary.

If a UE is configured with *pdsch-HARQ-ACK-CodebookList-r16*, *pdsch-HARQ-ACK-Codebook* is replaced by the relevant entry in *pdsch-HARQ-ACK-CodebookList-r16* in this clause.

If a UE is configured with *pdsch-HARQ-ACK-CodebookListMulticast-r17*, *pdsch-HARQ-ACK-Codebook* is replaced by the relevant entry in *pdsch-HARQ-ACK-CodebookListMulticast-r17* in this clause.

### 7.3.1.0 DCI size alignment

If necessary, padding or truncation shall be applied to the DCI formats according to the following steps executed in the order below:

## Step 0:

- Determine DCI format 0\_0 monitored in a common search space according to clause 7.3.1.1.1 where  $N_{RB}^{UL,BWP}$  is the size of the initial UL bandwidth part.
- Determine DCI format 1\_0 monitored in a common search space according to clause 7.3.1.2.1 where  $N_{RB}^{DL,BWP}$  is given by
  - the size of CORESET 0 if CORESET 0 is configured for the cell; and
  - the size of initial DL bandwidth part if CORESET 0 is not configured for the cell.
- If DCI format 0\_0 is monitored in common search space and if the number of information bits in the DCI format 0\_0 prior to padding is less than the payload size of the DCI format 1\_0 monitored in common search space for scheduling the same serving cell, a number of zero padding bits are generated for the DCI format 0\_0 until the payload size equals that of the DCI format 1\_0.
- If DCI format 0\_0 is monitored in common search space and if the number of information bits in the DCI format 0\_0 prior to truncation is larger than the payload size of the DCI format 1\_0 monitored in common search space for scheduling the same serving cell, the bitwidth of the frequency domain resource assignment field in the DCI format 0\_0 is reduced by truncating the first few most significant bits such that the size of DCI format 0\_0 equals the size of the DCI format 1\_0.

## Step 1:

- Determine DCI format 0\_0 monitored in a UE-specific search space according to clause 7.3.1.1.1 where  $N_{RB}^{UL,BWP}$  is the size of the active UL bandwidth part.
- Determine DCI format 1\_0 monitored in a UE-specific search space according to clause 7.3.1.2.1 where  $N_{RB}^{DL,BWP}$  is the size of the active DL bandwidth part.
- For a UE configured with *supplementaryUplink* in *ServingCellConfig* in a cell, if PUSCH is configured to be transmitted on both the SUL and the non-SUL of the cell and if the number of information bits in DCI format 0\_0 in UE-specific search space for the SUL is not equal to the number of information bits in DCI format 0\_0 in UE-specific search space for the non-SUL, a number of zero padding bits are generated for the smaller DCI format 0\_0 until the payload size equals that of the larger DCI format 0\_0.
- If DCI format 0\_0 is monitored in UE-specific search space and if the number of information bits in the DCI format 0\_0 prior to padding is less than the payload size of the DCI format 1\_0 monitored in UE-specific search space for scheduling the same serving cell, a number of zero padding bits are generated for the DCI format 0\_0 until the payload size equals that of the DCI format 1\_0.
- If DCI format 1\_0 is monitored in UE-specific search space and if the number of information bits in the DCI format 1\_0 prior to padding is less than the payload size of the DCI format 0\_0 monitored in UE-specific search space for scheduling the same serving cell, zeros shall be appended to the DCI format 1\_0 until the payload size equals that of the DCI format 0\_0.

## Step 2:

- Determine DCI format 0\_1 monitored in a UE-specific search space according to clause 7.3.1.1.2.
- Determine DCI format 1\_1 monitored in a UE-specific search space according to clause 7.3.1.2.2.
- For a UE configured with *supplementaryUplink* in *ServingCellConfig* in a cell, if PUSCH is configured to be transmitted on both the SUL and the non-SUL of the cell and if the number of information bits in format 0\_1 for the SUL is not equal to the number of information bits in format 0\_1 for the non-SUL, zeros shall be appended to smaller format 0\_1 until the payload size equals that of the larger format 0\_1.
- If the size of DCI format 0\_1 monitored in a UE-specific search space equals that of a DCI format 0\_0/1\_0 monitored in another UE-specific search space, one bit of zero padding shall be appended to DCI format 0\_1.
- If the size of DCI format 1\_1 monitored in a UE-specific search space equals that of a DCI format 0\_0/1\_0 monitored in another UE-specific search space, one bit of zero padding shall be appended to DCI format 1\_1.

## Step 2A:

- Determine DCI format 0\_2 monitored in a UE-specific search space according to clause 7.3.1.1.3.
- Determine DCI format 1\_2 monitored in a UE-specific search space according to clause 7.3.1.2.3.
- For a UE configured with *supplementaryUplink* in *ServingCellConfig* in a cell, if PUSCH is configured to be transmitted on both the SUL and the non-SUL of the cell and if the number of information bits in format 0\_2 for the SUL is not equal to the number of information bits in format 0\_2 for the non-SUL, zeros shall be appended to smaller format 0\_2 until the payload size equals that of the larger format 0\_2.

## Step 3:

- If both of the following conditions are fulfilled the size alignment procedure is complete
  - the total number of different DCI sizes configured to monitor is no more than 4 for the cell
  - the total number of different DCI sizes with C-RNTI configured to monitor is no more than 3 for the cell

## Step 4:

- Otherwise

## Step 4A:

- Remove the padding bit (if any) introduced in step 2 above.
- Determine DCI format 1\_0 monitored in a UE-specific search space according to clause 7.3.1.2.1 where  $N_{RB}^{DL,BWP}$  is given by
  - the size of CORESET 0 if CORESET 0 is configured for the cell; and
  - the size of initial DL bandwidth part if CORESET 0 is not configured for the cell.
- Determine DCI format 0\_0 monitored in a UE-specific search space according to clause 7.3.1.1.1 where  $N_{RB}^{UL,BWP}$  is the size of the initial UL bandwidth part.
- If the number of information bits in the DCI format 0\_0 monitored in a UE-specific search space prior to padding is less than the payload size of the DCI format 1\_0 monitored in UE-specific search space for scheduling the same serving cell, a number of zero padding bits are generated for the DCI format 0\_0 monitored in a UE-specific search space until the payload size equals that of the DCI format 1\_0 monitored in a UE-specific search space.
- If the number of information bits in the DCI format 0\_0 monitored in a UE-specific search space prior to truncation is larger than the payload size of the DCI format 1\_0 monitored in UE-specific search space for scheduling the same serving cell, the bitwidth of the frequency domain resource assignment field in the DCI format 0\_0 is reduced by truncating the first few most significant bits such that the size of DCI format 0\_0 monitored in a UE-specific search space equals the size of the DCI format 1\_0 monitored in a UE-specific search space.

## Step 4B:

- If the total number of different DCI sizes configured to monitor is more than 4 for the cell after applying the above steps, or if the total number of different DCI sizes with C-RNTI configured to monitor is more than 3 for the cell after applying the above steps
  - If the number of information bits in the DCI format 0\_2 prior to padding is less than the payload size of the DCI format 1\_2 for scheduling the same serving cell, a number of zero padding bits are generated for the DCI format 0\_2 until the payload size equals that of the DCI format 1\_2.
  - If the number of information bits in the DCI format 1\_2 prior to padding is less than the payload size of the DCI format 0\_2 for scheduling the same serving cell, zeros shall be appended to the DCI format 1\_2 until the payload size equals that of the DCI format 0\_2.

## Step 4C:

- If the total number of different DCI sizes configured to monitor is more than 4 for the cell after applying the above steps, or if the total number of different DCI sizes with C-RNTI configured to monitor is more than 3 for the cell after applying the above steps
- If the number of information bits in the DCI format 0\_1 prior to padding is less than the payload size of the DCI format 1\_1 for scheduling the same serving cell, a number of zero padding bits are generated for the DCI format 0\_1 until the payload size equals that of the DCI format 1\_1.
- If the number of information bits in the DCI format 1\_1 prior to padding is less than the payload size of the DCI format 0\_1 for scheduling the same serving cell, zeros shall be appended to the DCI format 1\_1 until the payload size equals that of the DCI format 0\_1.

The UE is not expected to handle a configuration that, after applying the above steps, results in

- the total number of different DCI sizes configured to monitor is more than 4 for the cell; or
- the total number of different DCI sizes with C-RNTI configured to monitor is more than 3 for the cell; or
- the size of DCI format 0\_0 in a UE-specific search space is equal to DCI format 0\_1 in another UE-specific search space; or
- the size of DCI format 1\_0 in a UE-specific search space is equal to DCI format 1\_1 in another UE-specific search space; or
- the size of DCI format 0\_0 in a UE-specific search space is equal to DCI format 0\_2 in another UE-specific search space when at least one pair of the corresponding PDCCH candidates of DCI formats 0\_0 and 0\_2 are mapped to the same resource; or
- the size of DCI format 1\_0 in a UE-specific search space is equal to DCI format 1\_2 in another UE-specific search space when at least one pair of the corresponding PDCCH candidates of DCI formats 1\_0 and 1\_2 are mapped to the same resource; or
- the size of DCI format 0\_1 in a UE-specific search space is equal to DCI format 0\_2 in the same or another UE-specific search space when at least one pair of the corresponding PDCCH candidates of DCI formats 0\_1 and 0\_2 are mapped to the same resource; or
- the size of DCI format 1\_1 in a UE-specific search space is equal to DCI format 1\_2 in the same or another UE-specific search space when at least one pair of the corresponding PDCCH candidates of DCI formats 1\_1 and 1\_2 are mapped to the same resource.

#### 7.3.1.0.1 DCI size alignment for DCI formats for scheduling of sidelink

If DCI format 3\_0 or DCI format 3\_1 is monitored on a cell, DCI size alignment for DCI format 3\_0 and DCI format 3\_1 is performed as described in this clause after performing the DCI size alignment described in Clause 7.3.1.0. The size(s) of the DCI formats configured to monitor for a cell in this clause refers to that after performing the DCI size alignment described in Clause 7.3.1.0.

If DCI format 3\_0 or DCI format 3\_1 is monitored on a cell and the total number of DCI sizes of the DCI formats configured to monitor for the cell and DCI format 3\_0 or DCI format 3\_1 is more than 4, zeros shall be appended to DCI format 3\_0 if configured and DCI format 3\_1 if configured, until the payload size of DCI format 3\_0 or DCI format 3\_1 equals that of the smallest DCI format configured to monitor for the cell that is larger than DCI format 3\_0 or DCI format 3\_1.

The UE is not expected to handle a configuration that results in:

- the total number of different DCI sizes configured to monitor for the cell and DCI format 3\_0 or DCI format 3\_1 is more than 4; and
- the payload size of DCI format 3\_0 or DCI format 3\_1 is larger than the payload size of all other DCI formats configured to monitor for the cell.

### 7.3.1.1 DCI formats for scheduling of PUSCH

#### 7.3.1.1.1 Format 0\_0

DCI format 0\_0 is used for the scheduling of PUSCH in one cell.

The following information is transmitted by means of the DCI format 0\_0 with CRC scrambled by C-RNTI or CS-RNTI or MCS-C-RNTI:

- Identifier for DCI formats – 1 bit
    - The value of this bit field is always set to 0, indicating an UL DCI format
  - Frequency domain resource assignment – number of bits determined by the following:
    - $\left\lceil \log_2(N_{RB}^{UL,BWP}(N_{RB}^{UL,BWP} + 1)/2) \right\rceil$  bits if neither of the higher layer parameters *useInterlacePUCCH-PUSCH* in *BWP-UplinkCommon* and *useInterlacePUCCH-PUSCH* in *BWP-UplinkDedicated* is configured, where  $N_{RB}^{UL,BWP}$  is defined in clause 7.3.1.0
    - For PUSCH hopping with resource allocation type 1:
      - $N_{UL\_hop}$  MSB bits are used to indicate the frequency offset according to Clause 6.3 of [6, TS 38.214], where  $N_{UL\_hop} = 1$  if the higher layer parameter *frequencyHoppingOffsetLists* contains two offset values and  $N_{UL\_hop} = 2$  if the higher layer parameter *frequencyHoppingOffsetLists* contains four offset values
      - $\left\lceil \log_2(N_{RB}^{UL,BWP}(N_{RB}^{UL,BWP} + 1)/2) \right\rceil - N_{UL\_hop}$  bits provide the frequency domain resource allocation according to Clause 6.1.2.2.2 of [6, TS 38.214]
    - For non-PUSCH hopping with resource allocation type 1:
      - $\left\lceil \log_2(N_{RB}^{UL,BWP}(N_{RB}^{UL,BWP} + 1)/2) \right\rceil$  bits provide the frequency domain resource allocation according to Clause 6.1.2.2.2 of [6, TS 38.214]
    - If any of the higher layer parameters *useInterlacePUCCH-PUSCH* in *BWP-UplinkCommon* and *useInterlacePUCCH-PUSCH* in *BWP-UplinkDedicated* is configured
      - 5+Y bits provide the frequency domain resource allocation according to Clause 6.1.2.2.3 of [6, TS 38.214] if the subcarrier spacing for the active UL bandwidth part is 30 kHz.
      - 6+Y bits provide the frequency domain resource allocation according to Clause 6.1.2.2.3 of [6, TS 38.214] if the subcarrier spacing for the active UL bandwidth part is 15 kHz.
- If the DCI format 0\_0 is monitored in a UE-specific search space, the value of Y is determined by  $\left\lceil \log_2 \left( \frac{N_{RB-set,UL}^{BWP}(N_{RB-set,UL}^{BWP} + 1)}{2} \right) \right\rceil$  where  $N_{RB-set,UL}^{BWP}$  is the number of RB sets contained in the active UL BWP as defined in clause 7 of [6, TS38.214]. If the DCI 0\_0 is monitored in a common search space Y = 0.
- Time domain resource assignment – 4 bits as defined in Clause 6.1.2.1 of [6, TS 38.214]
  - Frequency hopping flag – 1 bit according to Table 7.3.1.1.1-3, as defined in Clause 6.3 of [6, TS 38.214]
  - Modulation and coding scheme – 5 bits as defined in Clause 6.1.4.1 of [6, TS 38.214]
  - New data indicator – 1 bit
  - Redundancy version – 2 bits as defined in Table 7.3.1.1.1-2
  - HARQ process number – 4 bits
  - TPC command for scheduled PUSCH – 2 bits as defined in Clause 7.1.1 of [5, TS 38.213]

- ChannelAccess-CPext – 2 bits indicating combinations of channel access type and CP extension as defined in Table 7.3.1.1.1-4, or Table 7.3.1.1.1-4A if *channelAccessMode-r16* = "semiStatic" is provided, for operation in a cell with shared spectrum channel access in frequency range 1; 2 bits indicating channel access type as defined in Table 7.3.1.1.1-4B if *ChannelAccessMode2-r17* is provided for operation in a cell in frequency range 2-2; 0 bit otherwise.
- Padding bits, if required.
- UL/SUL indicator – 1 bit for UEs configured with *supplementaryUplink* in *ServingCellConfig* in the cell as defined in Table 7.3.1.1.1-1 and the number of bits for DCI format 1\_0 before padding is larger than the number of bits for DCI format 0\_0 before padding; 0 bit otherwise. The UL/SUL indicator, if present, locates in the last bit position of DCI format 0\_0, after the padding bit(s).
- If the UL/SUL indicator is present in DCI format 0\_0 and the higher layer parameter *pusch-Config* is not configured on both UL and SUL the UE ignores the UL/SUL indicator field in DCI format 0\_0, and the corresponding PUSCH scheduled by the DCI format 0\_0 is for the UL or SUL for which high layer parameter *pucch-Config* is configured;
- If the UL/SUL indicator is not present in DCI format 0\_0 and *pucch-Config* is configured, the corresponding PUSCH scheduled by the DCI format 0\_0 is for the UL or SUL for which high layer parameter *pucch-Config* is configured.
- If the UL/SUL indicator is not present in DCI format 0\_0 and *pucch-Config* is not configured, the corresponding PUSCH scheduled by the DCI format 0\_0 is for the uplink on which the latest PRACH is transmitted.

The following information is transmitted by means of the DCI format 0\_0 with CRC scrambled by TC-RNTI:

- Identifier for DCI formats – 1 bit
  - The value of this bit field is always set to 0, indicating an UL DCI format
- Frequency domain resource assignment – number of bits determined by the following:
  - $\left\lceil \log_2(N_{RB}^{UL,BWP}(N_{RB}^{UL,BWP} + 1)/2) \right\rceil$  bits if the higher layer parameter *useInterlacePUCCH-PUSCH* in *BWP-UplinkCommon* is not configured, where
    - $N_{RB}^{UL,BWP}$  is the size of the initial UL bandwidth part.
    - For PUSCH hopping with resource allocation type 1:
      - $N_{UL\_hop}$  MSB bits are used to indicate the frequency offset according to Table 8.3-1 in Clause 8.3 of [5, TS 38.213], where  $N_{UL\_hop} = 1$  if  $N_{RB}^{UL,BWP} < 50$  and  $N_{UL\_hop} = 2$  otherwise
      - $\left\lceil \log_2(N_{RB}^{UL,BWP}(N_{RB}^{UL,BWP} + 1)/2) \right\rceil - N_{UL\_hop}$  bits provide the frequency domain resource allocation according to Clause 6.1.2.2.2 of [6, TS 38.214]
    - For non-PUSCH hopping with resource allocation type 1:
      - $\left\lceil \log_2(N_{RB}^{UL,BWP}(N_{RB}^{UL,BWP} + 1)/2) \right\rceil$  bits provide the frequency domain resource allocation according to Clause 6.1.2.2.2 of [6, TS 38.214]
  - If the higher layer parameter *useInterlacePUCCH-PUSCH* in *BWP-UplinkCommon* is configured
    - 5 bits provide the frequency domain resource allocation according to Clause 6.1.2.2.3 of [6, TS 38.214] if the subcarrier spacing for the active UL bandwidth part is 30 kHz
    - 6 bits provide the frequency domain resource allocation according to Clause 6.1.2.2.3 of [6, TS 38.214] if the subcarrier spacing for the active UL bandwidth part is 15 kHz
- Time domain resource assignment – 4 bits as defined in Clause 6.1.2.1 of [6, TS 38.214]



- Frequency hopping flag – 1 bit according to Table 7.3.1.1.1-3, as defined in Clause 6.3 of [6, TS 38.214]
- Modulation and coding scheme – 5 bits
  - If the UE requests repetition of PUSCH scheduled by RAR UL grant [8, TS 38.321], 5 bits as defined in Clause 6.1.2.1 and Clause 6.1.4.1 of [6, TS 38.214];
  - otherwise 5 bits as defined in Clause 6.1.4.1 of [6, TS 38.214].
- New data indicator – 1 bit, reserved
- Redundancy version – 2 bits as defined in Table 7.3.1.1.1-2
- HARQ process number – 4 bits, reserved
- TPC command for scheduled PUSCH – 2 bits as defined in Clause 7.1.1 of [5, TS 38.213]
- ChannelAccess-CPext – 2 bits indicating combinations of channel access type and CP extension as defined in Table 7.3.1.1.1-4, or Table 7.3.1.1.1-4A if *channelAccessMode-r16* = "semiStatic" is provided, for operation in a cell with shared spectrum channel access in frequency range 1; 2 bits indicating channel access type as defined in Table 7.3.1.1.1-4B if *ChannelAccessMode2-r17* is provided for operation in a cell in frequency range 2-2; 0 bit otherwise
- Padding bits, if required.
- UL/SUL indicator – 1 bit if the cell has two ULs and the number of bits for DCI format 1\_0 before padding is larger than the number of bits for DCI format 0\_0 before padding; 0 bit otherwise. The UL/SUL indicator, if present, locates in the last bit position of DCI format 0\_0, after the padding bit(s).
- If 1 bit, reserved, and the corresponding PUSCH is always on the same UL carrier as the previous transmission of the same TB

**Table 7.3.1.1.1-1: UL/SUL indicator**

| Value of UL/SUL indicator | Uplink                       |
|---------------------------|------------------------------|
| 0                         | The non-supplementary uplink |
| 1                         | The supplementary uplink     |

**Table 7.3.1.1.1-2: Redundancy version**

| Value of the Redundancy version field | Value of $rv_{id}$ to be applied |
|---------------------------------------|----------------------------------|
| 00                                    | 0                                |
| 01                                    | 1                                |
| 10                                    |                                  |

**Table 7.3.1.1.1-4: Channel access type & CP extension for DCI format 0\_0 and DCI format 1\_0 for frequency range 1**

| Bit field mapped to index | Channel Access Type                                            | The CP extension T_"ext" index defined in Clause 5.3.1 of [4, TS 38.211] |
|---------------------------|----------------------------------------------------------------|--------------------------------------------------------------------------|
| 0                         | Type2C-ULChannelAccess defined in [clause 4.2.1.2.3 in 37.213] | 2                                                                        |
| 1                         | Type2A-ULChannelAccess defined in [clause 4.2.1.2.1 in 37.213] | 3                                                                        |
| 2                         | Type2A-ULChannelAccess defined in [clause 4.2.1.2.1 in 37.213] | 1                                                                        |
| 3                         | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 0                                                                        |

**Table 7.3.1.1.1-4A: Channel access type & CP extension if *channelAccessMode-r16* = "semiStatic" is provided**

| Bit field mapped to index                                                                                                   | Channel Access Type                                                  | The CP extension T_"ext" index defined in Clause 5.3.1 of [4, TS 38.211] | Initiator of the channel occupancy associated with the UL transmission as described in Clause 4.3.1 in TS 37.213 |
|-----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| 0                                                                                                                           | No sensing as defined in Clause 4.3 in TS 37.213                     | 0                                                                        | gNB                                                                                                              |
| 1                                                                                                                           | No sensing as defined in Clause 4.3 in TS 37.213                     | 2                                                                        | gNB                                                                                                              |
| 2                                                                                                                           | Sensing within a 25us interval as defined in Clause 4.3 in TS 37.213 | 0                                                                        | gNB                                                                                                              |
| 3                                                                                                                           | Sensing as defined in Clause 4.3.1.2 in TS 37.213                    | 0                                                                        | UE                                                                                                               |
| Note: Row index 3 is only applicable if <i>semiStaticChannelAccessConfigUE</i> is provided. Otherwise, the row is reserved. |                                                                      |                                                                          |                                                                                                                  |

- The value of this bit field is always set to 0, indicating an UL DCI format
- Carrier indicator – 0 or 3 bits, as defined in Clause 10.1 of [5, TS38.213]. This field is reserved when this format is carried by PDCCH on the primary cell and the UE is configured for scheduling on the primary cell from an SCell, with the same number of bits as that in this format carried by PDCCH on the SCell for scheduling on the primary cell.
- DFI flag – 0 or 1 bit
  - 1 bit if the UE is configured to monitor DCI format 0\_1 with CRC scrambled by CS-RNTI and for operation in a cell with shared spectrum channel access when the higher layer parameter *cg-RetransmissionTimer* is configured. For a DCI format 0\_1 with CRC scrambled by CS-RNTI, the bit value of 0 indicates activating or releasing type 2 CG transmission and the bit value of 1 indicates CG-DFI. For a DCI format 0\_1 with CRC scrambled by C-RNTI/SP-CRNTI/MCS-C-RNTI and for operation in a cell with shared spectrum channel access, the bit is reserved.
  - 0 bit otherwise;

If DCI format 0\_1 is used for indicating CG-DFI, all the remaining fields are set as follows:

- HARQ-ACK bitmap – 16 bits if *nrofHARQ-Processes-v1700* in *ConfiguredGrantConfig* is not configured or 32 bits if *nrofHARQ-Processes-v1700* in *ConfiguredGrantConfig* is configured, where the order of the bitmap to HARQ process index mapping is such that HARQ process indices are mapped in ascending order from MSB to LSB of the bitmap. For each bit of the bitmap, value 1 indicates ACK, and value 0 indicates NACK.
- TPC command for scheduled PUSCH – 2 bits as defined in Clause 7.1.1 of [5, TS38.213]
- All the remaining bits in format 0\_1 are set to zero.

Otherwise, all the remaining fields are set as follows:

- UL/SUL indicator – 0 bit for UEs not configured with *supplementaryUplink* in *ServingCellConfig* in the cell or UEs configured with *supplementaryUplink*

- For resource allocation type 0, the  $N_{\text{RBG}}$  LSBs provide the resource allocation as defined in Clause 6.1.2.2.1 of [6, TS 38.214].
- For resource allocation type 1, the  $\lceil \log_2(N_{\text{RB}}^{\text{UL,BWP}}(N_{\text{RB}}^{\text{UL,BWP}} + 1)/2) \rceil$  LSBs provide the resource allocation as follows:
  - For PUSCH hopping with resource allocation type 1:
    - $N_{\text{UL\_hop}}$  MSB bits are used to indicate the frequency offset according to Clause 6.3 of [6, TS 38.214], where  $N_{\text{UL\_hop}} = 1$  if the higher layer parameter *frequencyHoppingOffsetLists* contains two offset values and  $N_{\text{UL\_hop}} = 2$  if the higher layer parameter *frequencyHoppingOffsetLists* contains four offset values
    - $\lceil \log_2(N_{\text{RB}}^{\text{UL,BWP}}(N_{\text{RB}}^{\text{UL,BWP}} + 1)/2) \rceil - N_{\text{UL\_hop}}$  bits provide the frequency domain resource allocation according to Clause 6.1.2.2.2 of [6, TS 38.214]
  - For non-PUSCH hopping with resource allocation type 1:
    - $\lceil \log_2(N_{\text{RB}}^{\text{UL,BWP}}(N_{\text{RB}}^{\text{UL,BWP}} + 1)/2) \rceil$  bits provide the frequency domain resource allocation according to Clause 6.1.2.2.2 of [6, TS 38.214]

If "Bandwidth part indicator" field indicates a bandwidth part other than the active bandwidth part and if *resourceAllocation* is configured as 'dynamicSwitch' for the indicated bandwidth part, the UE assumes resource allocation type 0 for the indicated bandwidth part if the bitwidth of the "Frequency domain resource assignment" field of the active bandwidth part is smaller than the bitwidth of the "Frequency domain resource assignment" field of the indicated bandwidth part.

- If the higher layer parameter *useInterlacePUCCH-PUSCH* in *BWP-UplinkDedicated* is configured
  - 5 + Y bits provide the frequency domain resource allocation according to Clause 6.1.2.2.3 of [6, TS 38.2

*RepTypeB*, or if the higher layer parameter *frequencyHoppingDCI-0-1* is not configured and *pusch-RepTypeIndicatorDCI-0-1* is configured to *pusch-RepTypeB*, or if only resource allocation type 2 is configured;

- 1 bit according to Table 7.3.1.1.1-3 otherwise, only applicable to resource allocation type 1, as defined in Clause 6.3 of [6, TS 38.214].
- Modulation and coding scheme – 5 bits as defined in Clause 6.1.4.1 of [6, TS 38.214]
- New data indicator – 1 bit if the number of scheduled PUSCH indicated by the Time domain resource assignment field is 1; otherwise 2, 3, 4, 5, 6, 7 or 8 bits determined based on the maximum number of schedulable PUSCH among all entries in the higher layer parameter *pusch-TimeDomainAllocationListForMultiPUSCH*, where each bit corresponds to one scheduled PUSCH as defined in clause 6.1.4 in [6, TS 38.214].
- Redundancy version – number of bits determined by the following:
  - 2 bits as defined in Table 7.3.1.1.1-2 if the number of scheduled PUSCH indicated by the Time domain resource assignment field is 1;
  - otherwise 2, 3, 4, 5, 6, 7 or 8 bits determined by the maximum number of schedulable PUSCHs among all entries in the higher layer parameter *pusch-TimeDomainAllocationListForMultiPUSCH*, where each bit corresponds to one scheduled PUSCH as defined in clause 6.1.4 in [6, TS 38.214] and redundancy version is determined according to Table 7.3.1.1.2-34.
- HARQ process number – 5 bits if higher layer parameter *harq-ProcessNumberSizeDCI-0-1* is configured; otherwise 4 bits
- 1<sup>st</sup> downlink assignment index – 1, 2 or 4 bits:
  - 1 bit for semi-static HARQ-ACK codebook for unicast and multicast if *pdsch-HARQ-ACK-Codebook = semiStatic* is configured for both unicast and multicast and the higher layer parameter *fdmed-ReceptionMulticast* is not configured; otherwise for semi-static HARQ-ACK codebook for unicast;
  - 2 bits for dynamic HARQ-ACK codebook for unicast, or for enhanced dynamic HARQ-ACK codebook without *UL-TotalDAI-Included* configured;
  - 4 bits for enhanced dynamic HARQ-ACK codebook and with *UL-TotalDAI-Included = true*.

- 1 bit for semi-static HARQ-ACK codebook for multicast if the higher layer parameter *fdmed-ReceptionMulticast* is configured;
- 2 bits for the dynamic HARQ-ACK codebook for multicast;
- 0 bit otherwise.

When two HARQ-ACK codebooks are configured by *pdsch-HARQ-ACK-CodebookListMulticast* for the same serving cell and if higher layer parameter *priorityIndicatorDCI-0-1* is configured, if the bit width of the 3<sup>rd</sup> downlink assignment index in DCI format 0\_1 for one HARQ-ACK codebook is not equal to that of the 3<sup>rd</sup> downlink assignment index in DCI format 0\_1 for the other HARQ-ACK codebook, a number of most significant bits with value set to '0' are inserted to smaller 3<sup>rd</sup> downlink assignment index until the bit width of the 3<sup>rd</sup> downlink assignment index in DCI format 0\_1 for the two HARQ-ACK codebooks are the same.

- TPC command for scheduled PUSCH – 2 bits as defined in Clause 7.1.1 of [5, TS38.213]
- Second TPC command for scheduled PUSCH – 2 bits as defined in Clause 7.1.1 of [5, TS38.213] if higher layer parameter *SecondTPCFieldDCI-0-1* is configured; 0 bit otherwise.
- SRS resource set indicator – 0 or 2 bits
  - 2 bits according to Table 7.3.1.1.2-36 if
    - *txConfig* = *nonCodeBook*, and there are two SRS resource sets configured by *srs-ResourceSetToAddModList* and associated with the *usage* of value '*nonCodeBook*', or
    - *txConfig*=*codebook*, and there are two SRS resource sets configured by *srs-ResourceSetToAddModList* and associated with *usage* of value '*codebook*';
  - 0 bit otherwise.
- SRS resource indicator –  $\left\lceil \log_2 \left( \sum_{k=1}^{\min\{L_{\max}, N_{\text{SRS}}\}} \binom{N_{\text{SRS}}}{k} \right) \right\rceil$  or  $\lceil \log_2(N_{\text{SRS}}) \rceil$  bits, where  $N_{\text{SRS}}$  is the

- $\left\lceil \log_2 \left( \max_{k \in \{1, 2, \dots, \min\{L_{max}, N_{SRS}\}\}} \binom{N_{SRS}}{k} \right) \right\rceil$  bits according to Tables 7.3.1.1.2-28/29A/30A/31A with the same number of layers indicated by SRS resource indicator field if the higher layer parameter *txConfig* = *nonCodebook* and SRS resource set indicator field is present, where  $N_{SRS}$  is the number of configured SRS resources in the second SRS resource set, and
  - if UE supports operation with *maxMIMO-Layers* and the higher layer parameter *maxMIMO-Layers* of *PUSCH-ServingCellConfig* of the serving cell is configured,  $L_{max}$  is given by that parameter
  - otherwise,  $L_{max}$  is given by the maximum number of layers for PUSCH supported by the UE for the serving cell for non-codebook based operation.
- $\lceil \log_2(N_{SRS}) \rceil$  bits according to Tables 7.3.1.1.2-32, 7.3.1.1.2-32A and 7.3.1.1.2-32B if the higher layer parameter *txConfig* = *codebook* and SRS resource set indicator field is present, where  $N_{SRS}$  is the number of configured SRS resources in the second SRS resource set.
- 0 bit otherwise.
- Precoding information and number of layers – number of bits determined by the following:
  - 0 bits if the higher layer parameter *txConfig* = *nonCodeBook*;
  - 0 bits for 1 antenna port and if the higher layer parameter *txConfig* = *codebook*;
  - 4, 5, or 6 bits according to Table 7.3.1.1.2-2 for 4 antenna ports, if *txConfig* = *codebook*, *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower*, transform precoder is disabled, and according to the values of higher layer parameters *maxRank*, and *codebookSubset*;
  - 4 or 5 bits according to Table 7.3.1.1.2-2A for 4 antenna ports, if *txConfig* = *codebook*, *ul-FullPowerTransmission* = *fullpowerMode1*, *maxRank*=2, transform precoder is disabled, and according to the values of higher layer parameter *codebookSubset*;
  - 4 or 6

For the higher layer parameter *txConfig=codebook*, if *ul-FullPowerTransmission* is configured to *fullpowerMode2*, *maxRank* is configured to be larger than 2, and at least one SRS resource with 4 antenna ports is configured in the SRS resource set indicated by SRS resource set indicator field if present, otherwise in an SRS resource set with usage set to 'codebook', and an SRS resource with 2 antenna ports is indicated via SRI in the same SRS resource set, then Table 7.3.1.1.2-4 is used.

For the higher layer parameter *txConfig = codebook*, if different SRS resources with different number of antenna ports are configured, the bitwidth is determined according to the maximum number of ports in an SRS resource among the configured SRS resources in all SRS resource set(s) with usage set to 'codebook'. If the number of ports for a configured SRS resource in the set is less than the maximum number of ports in an SRS resource among the configured SRS resources, a number of most significant bits with value set to '0' are inserted to the field.

- Second Precoding information – number of bits determined by the following:
  - 0 bits if SRS resource set indicator field is not present;
  - 0 bits if the higher layer parameter *txConfig = nonCodeBook*;
  - 0 bits for 1 antenna port and if the higher layer parameter *txConfig = codebook*;
  - 3, 4, or 5 bits according to Table 7.3.1.1.2-2C with the same number of layers indicated by Precoding information and number of layers field for 4 antenna ports, if SRS resource set indicator field is present, *txConfig = codebook*, *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower*, transform precoder is disabled, and according to the values of higher layer parameters *maxRank*, and *codebookSubset*;
  - 3 or 4 bits according to Table 7.3.1.1.2-2D with the same number of layers indicated by Precoding information and number of layers field for 4 antenna ports, if SRS resource set indicator field is present, *txConfig = codebook*, *ul-FullPowerTransmission = fullpowerMode1*, *maxRank=2*, transform precoder is disabled, and according to the values of higher layer parameter *codebookSubset*;
  - 3 or 4 bits according to Table 7.3.1.1.2-2E with the same number of layers indicated by Precoding information and number



- 2 bits according to Table 7.3.1.1.2-5A with the same number of layers indicated by Precoding information and number of layers field for 2 antenna ports, if SRS resource set indicator field is present,  $txConfig = codebook$ ,  $ul-FullPowerTransmission = fullpowerMode1$ ,  $maxRank=1$ , and according to whether transform precoder is enabled or disabled, and the values of higher layer parameter  $codebookSubset$ ;

For the higher layer parameter  $txConfig=codebook$ , if  $ul-FullPowerTransmission$  is configured to  $fullpowerMode2$ ,  $maxRank$  is configured to be larger than 2, and at least one SRS resource with 4 antenna ports is configured in the SRS resource set indicated by SRS resource set indicator field, and an SRS resource with 2 antenna ports is indicated via Second SRS resource indicator field in the same SRS resource set, then Table 7.3.1.1.2-4B is used.

For the higher layer parameter  $txConfig = codebook$ , if different SRS resources with different number of antenna ports are configured, the bitwidth is determined according to the maximum number of ports in an SRS resource among the configured SRS resources in the second SRS resource set with usage set to 'codebook' as defined in Table 7.3.1.1.2-36. If the number of ports for a configured SRS resource in the set is less than the maximum number of ports in an SRS resource among the configured SRS resources, a number of most significant bits with value set to '0' are inserted to the field.

- Antenna ports – number of bits determined by the following
  - 2 bits as defined by Tables 7.3.1.1.2-6, if transform precoder is enabled,  $dmrs-Type=1$ , and  $maxLength=1$ , except that  $dmrs-UplinkTransformPrecoding$  and  $tp-pi2BPSK$  are both configured and  $\pi/2$  BPSK modulation is used;
  - 2 bits as defined by Tables 7.3.1.1.2-6A, if transform precoder is enabled and  $dmrs-UplinkTransformPrecoding$  and  $tp-pi2BPSK$  are both configured,  $\pi/2$  BPSK modulation is used,  $dmrs-Type=1$ , and  $maxLength=1$ , where  $n_{SCID}$  is the scrambling identity for antenna ports defined in [Clause 6.4.1.1.1.2, TS38.211];
  - 4 bits as defined by Tables 7.3.1.1.2-7, if transform precoder is enabled,  $dmrs-Type=1$ , and  $maxLength=2$ , except that  $dmrs-UplinkTransformPrecoding$  and  $tp-pi2BPSK$  are both configured and  $\pi/2$  BPSK modulation is used;
  - 4 bits as defined by Tables 7.3.1.1.2-7A, if transform precoder is enabled and  $dmrs-UplinkTransformPrecoding$  and  $tp-pi2BPSK$  are both configured,  $\pi/2$  BPSK modulation is used,  $dmrs-Type=1$ , and  $maxLength=2$ , where  $n_{SCID}$  is the scrambling identity for antenna ports defined in [Clause 6.4.1.1.1.2, TS38.211];
  - 3 bits as defined by Tables 7.3.1.1.2-8/9/10/11, if transform precoder is disabled,  $dmrs-Type=1$ , and  $maxLength=1$ , and the value of rank is determined according to the SRS resource indicator field if the higher layer parameter  $txConfig = nonCodebook$  and according to the Precoding information and number of layers field if the higher layer parameter  $txConfig = codebook$ ;
  - 4 bits as defined by Tables 7.3.1.1.2-12/13/14/15, if transform precoder is disabled,  $dmrs-Type=1$ , and  $maxLength=2$ , and the value of rank is determined according to the SRS resource indicator field if the higher layer parameter  $txConfig = nonCodebook$  and according to the Precoding information and number of layers field if the higher layer parameter  $txConfig = codebook$ ;
  - 4 bits as defined by Tables 7.3.1.1.2-16/17/18/19, if transform precoder is disabled,  $dmrs-Type=2$ , and  $maxLength=1$ , and the value of rank is determined according to the SRS resource indicator field if the higher layer parameter  $txConfig = nonCodebook$  and according to the Precoding information and number of layers field if the higher layer parameter  $txConfig = codebook$ ;
  - 5 bits as defined by Tables 7.3.1.1.2-20/21/22/23, if transform precoder is disabled,  $dmrs-Type=2$ , and  $maxLength=2$ , and the value of rank is determined according to the SRS resource indicator field if the higher layer parameter  $txConfig = nonCodebook$  and according to the Precoding information and number of layers field if the higher layer parameter  $txConfig = codebook$ .

where the number of CDM groups without data of values 1, 2, and 3 in Tables 7.3.1.1.2-6 to 7.3.1.1.2-23 refers to CDM groups {0}, {0,1}, and {0, 1,2} respectively.

If a UE is configured with both  $dmrs-UplinkForPUSCH-MappingTypeA$  and  $dmrs-UplinkForPUSCH-MappingTypeB$ , the bitwidth of this field equals  $\max\{x_A, x_B\}$ , where  $x_A$  is the "Antenna ports" bitwidth

derived according to *dmrs-UplinkForPUSCH-MappingTypeA* and  $x_B$  is the "Antenna ports" bitwidth derived according to *dmrs-UplinkForPUSCH-MappingTypeB*. A number of  $|x_A - x_B|$  zeros are padded in the MSB of this field, if the mapping type of the PUSCH corresponds to the smaller value of  $x_A$  and  $x_B$ .

- SRS request – 2 bits as defined by Table 7.3.1.1.2-24 for UEs not configured with *supplementaryUplink* in *ServingCellConfig* in the cell; 3 bits for UEs configured with *supplementaryUplink* in *ServingCellConfig* in the cell where the first bit is the non-SUL/SUL indicator as defined in Table 7.3.1.1.1-1 and the second and third bits are defined by Table 7.3.1.1.2-24. This bit field may also indicate the associated CSI-RS according to Clause 6.1.1.2 of [6, TS 38.214].
- SRS offset indicator – 0, 1 or 2 bits.
  - 0 bit if higher layer parameter *AvailableSlotOffset* is not configured for any aperiodic SRS resource set in the scheduled cell, or if higher layer parameter *AvailableSlotOffset* is configured for at least one aperiodic SRS resource set in the scheduled cell and the maximum number of entries of *availableSlotOffsetList* configured for all aperiodic SRS resource set(s) is 1;
  - otherwise,  $\lceil \log_2(K) \rceil$  bits are used to indicate available slot offset according to Table 7.3.1.1.2-37 and Clause 6.2.1 of [6, TS 38.214], where K is the maximum number of entries of *availableSlotOffsetList* configured for all aperiodic SRS resource set(s) in the scheduled cell;
- CSI request – 0, 1, 2, 3, 4, 5, or 6 bits determined by higher layer parameter *reportTriggerSize*.
- CBG transmission information (CBGTI) – 0 bit if higher layer parameter *codeBlockGroupTransmission* for PUSCH is not configured or if the number of scheduled PUSCH indicated by the Time domain resource assignment field is larger than 1; otherwise, 2, 4, 6, or 8 bits determined by higher layer parameter *maxCodeBlockGroupsPerTransportBlock* for PUSCH.
- PTRS-DMRS association – number of bits determined as follows
  - 0 bit if *PTRS-UplinkConfig* is not configured in either *dmrs-UplinkForPUSCH-MappingTypeA* or *dmrs-UplinkForPUSCH-MappingTypeB* and transform precoder is disabled, or if transform precoder is enabled, or if *maxRank*=1 or *maxMIMO-Layers*=1;
  - 2 bits otherwise, where Table 7.3.1.1.2-25/7.3.1.1.2-25A and 7.3.1.1.2-26 are used to indicate the association between PTRS port(s) and DMRS port(s) when one PT-RS port and two PT-RS ports are configured by *maxNrofPorts* in *PTRS-UplinkConfig* respectively, and the DMRS ports are indicated by the Antenna ports field. When the SRS resource set indicator field is present and *maxRank*>2 or *maxMIMO-Layers*>2, this field indicates the association between PTRS port(s) and DMRS port(s) corresponding to SRS resource indicator field and/or Precoding information and number of layers field according to Table 7.3.1.1.2-25 and 7.3.1.1.2-26. When the SRS resource set indicator field is present and equals "10" or "11" and *maxRank*=2 or *maxMIMO-Layers*=2, the MSB of this field indicates the association between PTRS port(s) and DMRS port(s) corresponding to SRS resource indicator and/or Precoding information and number of layers field, and the LSB of this field indicates the association between PTRS port(s) and DMRS port(s) corresponding to Second SRS resource indicator field and/or Second Precoding information field, according to Table 7.3.1.1.2-25A.

If "Bandwidth part indicator" field indicates a bandwidth part other than the active bandwidth part and the "PTRS-DMRS association" field is present for the indicated bandwidth part but not present for the active bandwidth part, the UE assumes the "PTRS-DMRS association" field is not present for the indicated bandwidth part.

- Second PTRS-DMRS association – 2 bits if PTRS-DMRS association field and SRS resource set indicator field are present and *maxRank*>2 or *maxMIMO-Layers*>2; 0 bit otherwise. Table 7.3.1.1.2-25 and 7.3.1.1.2-26 are used to indicate the association between PTRS port(s) and DMRS port(s) corresponding to Second SRS resource indicator field and/or Second precoding information field when one PT-RS port and two PT-RS ports are configured by *maxNrofPorts* in *PTRS-UplinkConfig* respectively, and the DMRS ports are indicated by the Antenna ports field.
- beta\_offset indicator – 0 if the higher layer parameter *betaOffsets* = *semiStatic*; otherwise 2 bits as defined by Table 9.3-3 in [5, TS 38.213].

When two HARQ-ACK codebooks are configured by *pdsch-HARQ-ACK-CodebookList* or by *pdsch-HARQ-ACK-CodebookListMulticast* for the same serving cell and if higher layer parameter *priorityIndicatorDCI-0-1* is configured, if the bit width of the *beta\_offset* indicator in DCI format 0\_1 for one HARQ-ACK codebook is not equal to that of the *beta\_offset* indicator in DCI format 0\_1 for the other HARQ-ACK codebook, a number of most significant bits with value set to '0' are inserted to smaller *beta\_offset* indicator until the bit width of the *beta\_offset* indicator in DCI format 0\_1 for the two HARQ-ACK codebooks are the same.

- DMRS sequence initialization – 0 bit if transform precoder is enabled; 1 bit if transform precoder is disabled.
- UL-SCH indicator – 0 or 1 bit as follows
  - 0 bit if the number of scheduled PUSCH indicated by the Time domain resource assignment field is larger than 1;
  - 1 bit otherwise. A value of "1" indicates UL-SCH shall be transmitted on the PUSCH and a value of "0" indicates UL-SCH shall not be transmitted on the PUSCH. If a UE does not support triggering SRS only in DCI, except for DCI format 0\_1 with CRC scrambled by SP-CSI-RNTI, the UE is not expected to receive a DCI format 0\_1 with UL-SCH indicator of "0" and CSI request of all zero(s). If a UE supports triggering SRS only in DCI, except for DCI format 0\_1 with CRC scrambled by SP-CSI-RNTI, the UE is not expected to receive a DCI format 0\_1 with UL-SCH indicator of "0", CSI request of all zero(s) and SRS request of all zero(s).
- ChannelAccess-CPext-CAPC – 0, 1, 2, 3, 4, 5 or 6 bits. The bitwidth for this field is determined as  $\lceil \log_2(I) \rceil$  bits, where  $I$  is the number of entries in the higher layer parameter *ul-AccessConfigListDCI-0-1* or in Table 7.3.1.1.1-4A if *channelAccessMode-r16* = "semiStatic" is provided, for operation in a cell with shared spectrum channel access in frequency range 1, or for operation in frequency range 2-2 if *ChannelAccessMode2-r17* is provided; otherwise 0 bit. One or more entries from Table 7.3.1.1.2-35 or Table 7.3.1.1.2-35A are configured by the higher layer parameter *ul-AccessConfigListDCI-0-1*.
- Open-loop power control parameter set indication – 0 or 1 or 2 bits.
  - 0 bit if the higher layer parameter *p0-PUSCH-SetList* is not configured;
  - 1 or 2 bits otherwise,
    - 1 bit if SRS resource indicator is present in the DCI format 0\_1;
    - 1 or 2 bits as determined by higher layer parameter *olpc-ParameterSetDCI-0-1* if SRS resource indicator is not present in the DCI format 0\_1.
- Priority indicator – 0 bit if higher layer parameter *priorityIndicatorDCI-0-1* is not configured; otherwise 1 bit as defined in Clause 9 in [5, TS 38.213].
- Invalid symbol pattern indicator – 0 bit if higher layer parameter *invalidSymbolPatternIndicatorDCI-0-1* is not configured; otherwise 1 bit as defined in Clause 6.1.2.1 in [6, TS 38.214].
- Minimum applicable scheduling offset indicator – 0 or 1 bit
  - 0 bit if higher layer parameter *minimumSchedulingOffsetK2* is not configured;
  - 1 bit if higher layer parameter *minimumSchedulingOffsetK2* is configured. The 1 bit indication is used to determine the minimum applicable K2 for the active UL BWP and the minimum applicable K0 value for the active DL BWP, if configured respectively, according to Table 7.3.1.1.2-33. If the minimum applicable K0 is indicated, the minimum applicable value of the aperiodic CSI-RS triggering offset for an active DL BWP shall be the same as the minimum applicable K0 value.
- SCell dormancy indication – 0 bit if higher layer parameter *dormancyGroupWithinActiveTime* is not configured; otherwise 1, 2, 3, 4 or 5 bits bitmap determined according to the number of different *DormancyGroupID(s)* provided by higher layer parameter *dormancyGroupWithinActiveTime*, where each bit corresponds to one of the SCell group(s) configured by higher layers parameter *dormancyGroupWithinActiveTime*, with MSB to LSB of the bitmap corresponding to the first to last configured SCell group in ascending order of *DormancyGroupID*. The field is only present when this format is carried by PDCCH on the primary cell within DRX Active Time and the UE is configured with at least two DL BWPs for an SCell.
- Sidelink assignment index – 0, 1 or 2 bits:

- 1 bit if the UE is configured with *pdsch-HARQ-ACK-Codebook* = *semi-static* and, in addition, the UE is configured with a SL configured grant type 1 or to monitor DCI format 3\_0 with CRC scrambled by SL-RNTI or SL-CS-RNTI;
- 2 bits if the UE is configured with *pdsch-HARQ-ACK-Codebook* = *dynamic* and, in addition, the UE is configured with a SL configured grant type 1 or to monitor DCI format 3\_0 with CRC scrambled by SL-RNTI or SL-CS-RNTI;
- 0 bit otherwise.
- PDCCH monitoring adaptation indication – 0, 1 or 2 bits
  - 1 or 2 bits, if *searchSpaceGroupIdList-r17* is not configured and if *pdccch-SkippingDurationList* is configured
    - 1 bit if the UE is configured with only one duration by *pdccch-SkippingDurationList*;
    - 2 bits if the UE is configured with more than one duration by *pdccch-SkippingDurationList*.
  - 1 or 2 bits, if *pdccch-SkippingDurationList* is not configured and if *searchSpaceGroupIdList-r17* is configured
    - 1 bit if the UE is configured by *searchSpaceGroupIdList-r17* with search space set(s) with group index 0 and search space set(s) with group index 1, and if the UE is not configured by *searchSpaceGroupIdList-r17* with any search space set with group index 2;
    - 2 bits if the UE is configured by *searchSpaceGroupIdList-r17* with search space set(s) with group index 0, search space set(s) with group index 1 and search space set(s) with group index 2;
  - 2 bits, if *pdccch-SkippingDurationList* is configured and if *searchSpaceGroupIdList-r17* is configured
  - 0 bit, otherwise

A UE does not expect that the bit width of a field in DCI format 0\_1 with CRC scrambled by CS-RNTI is larger than corresponding bit width of same field in DCI format 0\_1 with CRC scrambled by C-RNTI for the same serving cell. If the bit width of a field in the DCI format 0\_1 with CRC scrambled by CS-RNTI is not equal to that of the corresponding field in the DCI format 0\_1 with CRC scrambled by C-RNTI for the same serving cell, a number of most significant bits with value set to '0' are inserted to the field in DCI format 0\_1 with CRC scrambled by CS-RNTI until the bit width equals that of the corresponding field in the DCI format 0\_1 with CRC scrambled by C-RNTI for the same serving cell.

If the number of information bits in DCI format 0\_1 scheduling a single PUSCH prior to padding is not equal to the number of information bits in DCI format 0\_1 scheduling multiple PUSCHs for the same serving cell, zeros shall be appended to the DCI format 0\_1 with smaller size until the payload size is the same for scheduling a single PUSCH and multiple PUSCHs.

For a UE configured with scheduling on the primary cell from an SCell, if prior to padding the number of information bits in DCI format 0\_1 carried by PDCCH on the primary cell is not equal to the number of information bits in DCI format 0\_1 carried by PDCCH on the SCell for scheduling on the primary cell, zeros shall be appended to the DCI format 0\_1 with smaller size until the payload size is the same.

- If application of step 4C in clause 7.3.1.0 results in additional zero padding for DCI format 0\_1 for scheduling on the primary cell, corresponding zeros shall be appended to both DCI format 0\_1 monitored on the primary cell and DCI format 0\_1 monitored on the SCell for scheduling on the primary cell.
- If the SCell is deactivated and *firstActiveDownlinkBWP-Id* is not set to dormant BWP, the UE determines the number of information bits in DCI format 0\_1 carried by PDCCH on the primary cell based on a DL BWP provided by *firstActiveDownlinkBWP-Id* for the SCell. If the active DL BWP of the SCell is a dormant DL BWP, or if the SCell is deactivated and *firstActiveDownlinkBWP-Id* is set to dormant BWP, the UE determines the number of information bits in DCI format 0\_1 carried by PDCCH on the primary cell based on a DL BWP provided by *firstWithinActiveTimeBWP-Id* for the SCell if provided; otherwise, based on a DL BWP provided by *firstOutsideActiveTimeBWP-Id* for the SCell.

Table 7.3.1.1.2-1: Bandwidth part indicator

| Value of BWP indicator field<br>2 bits | Bandwidth part                 |
|----------------------------------------|--------------------------------|
| 00                                     | Configured BWP with BWP-Id = 1 |
| 01                                     | Configured BWP with BWP-Id = 2 |
| 10                                     | Configured BWP with BWP-Id = 3 |
| 11                                     | Configured BWP with BWP-Id = 4 |

**Table 7.3.1.1.2-2: Precoding information and number of layers, for 4 antenna ports, if transform precoder is disabled,  $maxRank = 2$  or  $3$  or  $4$ , and *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower***

| Bit field mapped to index | <i>codebookSubset = fullyAndPartialAndNonCoherent</i> | Bit field mapped to index | <i>codebookSubset = partialAndNonCoherent</i> | Bit field mapped to index | <i>codebookSubset = nonCoherent</i> |
|---------------------------|-------------------------------------------------------|---------------------------|-----------------------------------------------|---------------------------|-------------------------------------|
| 0                         | 1 layer: TPMI=0                                       | 0                         | 1 layer: TPMI=0                               | 0                         | 1 layer: TPMI=0                     |
| 1                         | 1 layer: TPMI=1                                       | 1                         | 1 layer: TPMI=1                               | 1                         | 1 layer: TPMI=1                     |
| ...                       | ...                                                   | ...                       | ...                                           | ...                       | ...                                 |
| 3                         | 1 layer: TPMI=3                                       | 3                         | 1 layer: TPMI=3                               | 3                         | 1 layer: TPMI=3                     |
| 4                         | 2 layers: TPMI=0                                      | 4                         | 2 layers: TPMI=0                              | 4                         | 2 layers: TPMI=0                    |
| ...                       | ...                                                   | ...                       | ...                                           | ...                       | ...                                 |
| 9                         | 2 layers: TPMI=5                                      | 9                         | 2 layers: TPMI=5                              | 9                         | 2 layers: TPMI=5                    |
| 10                        | 3 layers: TPMI=0                                      | 10                        | 3 layers: TPMI=0                              | 10                        | 3 layers: TPMI=0                    |
| 11                        | 4 layers: TPMI=0                                      | 11                        | 4 layers: TPMI=0                              | 11                        | 4 layers: TPMI=0                    |
| 12                        | 1 layer: TPMI=4                                       | 12                        | 1 layer: TPMI=4                               | 12-15                     | reserved                            |
| ...                       | ...                                                   | ...                       | ...                                           |                           |                                     |
| 19                        | 1 layer: TPMI=11                                      | 19                        | 1 layer: TPMI=11                              |                           |                                     |
| 20                        | 2 layers: TPMI=6                                      | 20                        | 2 layers: TPMI=6                              |                           |                                     |
| ...                       | ...                                                   | ...                       | ...                                           |                           |                                     |
| 27                        | 2 layers: TPMI=13                                     | 27                        | 2 layers: TPMI=13                             |                           |                                     |
| 28                        | 3 layers: TPMI=1                                      | 28                        | 3 layers: TPMI=1                              |                           |                                     |
| 29                        | 3 layers: TPMI=2                                      | 29                        | 3 layers: TPMI=2                              |                           |                                     |
| 30                        | 4 layers: TPMI=1                                      | 30                        | 4 layers: TPMI=1                              |                           |                                     |
| 31                        | 4 layers: TPMI=2                                      | 31                        | 4 layers: TPMI=2                              |                           |                                     |
| 32                        | 1 layer: TPMI=12                                      |                           |                                               |                           |                                     |
| ...                       | ...                                                   |                           |                                               |                           |                                     |
| 47                        | 1 layer: TPMI=27                                      |                           |                                               |                           |                                     |
| 48                        | 2 layers: TPMI=14                                     |                           |                                               |                           |                                     |
| ...                       | ...                                                   |                           |                                               |                           |                                     |
| 55                        | 2 layers: TPMI=21                                     |                           |                                               |                           |                                     |
| 56                        | 3 layers: TPMI=3                                      |                           |                                               |                           |                                     |
| ...                       | ...                                                   |                           |                                               |                           |                                     |
| 59                        | 3 layers: TPMI=6                                      |                           |                                               |                           |                                     |
| 60                        | 4 layers: TPMI=3                                      |                           |                                               |                           |                                     |
| 61                        | 4 layers: TPMI=4                                      |                           |                                               |                           |                                     |
| 62-63                     | reserved                                              |                           |                                               |                           |                                     |

**Table 7.3.1.1.2-2A: Precoding information and number of layers for 4 antenna ports, if transform precoder is disabled,  $maxRank = 2$ , and  $ul-FullPowerTransmission = fullpowerMode1$**

| Bit field mapped to index | <i>codebookSubset = partialAndNonCoherent</i> | Bit field mapped to index | <i>codebookSubset = nonCoherent</i> |
|---------------------------|-----------------------------------------------|---------------------------|-------------------------------------|
| 0                         | 1 layer: TPMI=0                               | 0                         | 1 layer: TPMI=0                     |
| 1                         | 1 layer: TPMI=1                               | 1                         | 1 layer: TPMI=1                     |
| ...                       | ...                                           | ...                       | ...                                 |
| 3                         | 1 layer: TPMI=3                               | 3                         | 1 layer: TPMI=3                     |
| 4                         | 2 layers: TPMI=0                              | 4                         | 2 layers: TPMI=0                    |
| ...                       | ...                                           | ...                       | ...                                 |
| 9                         | 2 layers: TPMI=5                              | 9                         | 2 layers: TPMI=5                    |
| 10                        | 1 layer: TPMI=13                              | 10                        | 1 layer: TPMI=13                    |
| 11                        | 2 layer: TPMI=6                               | 11                        | 2 layer: TPMI=6                     |
| 12                        | 1 layer: TPMI=4                               | 12-15                     | Reserved                            |
| ...                       | ...                                           |                           |                                     |
| 20                        | 1 layer: TPMI=12                              |                           |                                     |
| 21                        | 1 layer: TPMI=14                              |                           |                                     |
| 22                        | 1 layer: TPMI=15                              |                           |                                     |
| 23                        | 2 layers: TPMI=7                              |                           |                                     |
| ...                       | ...                                           |                           |                                     |
| 29                        | 2 layers: TPMI=13                             |                           |                                     |
| 30-31                     | Reserved                                      |                           |                                     |

**Table 7.3.1.1.2-2B: Precoding information and number of layers for 4 antenna ports, if transform precoder is disabled,  $maxRank = 3$  or 4, and  $ul-FullPowerTransmission = fullpowerMode1$**

| Bit field mapped to index | <i>codebookSubset = partialAndNonCoherent</i> | Bit field mapped to index | <i>codebookSubset = nonCoherent</i> |
|---------------------------|-----------------------------------------------|---------------------------|-------------------------------------|
| 0                         | 1 layer: TPMI=0                               | 0                         | 1 layer: TPMI=0                     |
| 1                         | 1 layer: TPMI=1                               | 1                         | 1 layer: TPMI=1                     |
| ...                       | ...                                           | ...                       | ...                                 |
| 3                         | 1 layer: TPMI=3                               | 3                         | 1 layer: TPMI=3                     |
| 4                         | 2 layers: TPMI=0                              | 4                         | 2 layers: TPMI=0                    |
| ...                       | ...                                           | ...                       | ...                                 |
| 9                         | 2 layers: TPMI=5                              | 9                         | 2 layers: TPMI=5                    |
| 10                        | 3 layers: TPMI=0                              | 10                        | 3 layers: TPMI=0                    |
| 11                        | 4 layers: TPMI=0                              | 11                        | 4 layers: TPMI=0                    |
| 12                        | 1 layer: TPMI=13                              | 12                        | 1 layer: TPMI=13                    |
| 13                        | 2 layer: TPMI=6                               | 13                        | 2 layer: TPMI=6                     |
| 14                        | 3 layer: TPMI=1                               | 14                        | 3 layer: TPMI=1                     |
| 15                        | 1 layer: TPMI=4                               | 15                        | Reserved                            |
| ...                       | ...                                           |                           |                                     |
| 23                        | 1 layer: TPMI=12                              |                           |                                     |
| 24                        | 1 layer: TPMI=14                              |                           |                                     |
| 25                        | 1 layer: TPMI=15                              |                           |                                     |
| 26                        | 2 layers: TPMI=7                              |                           |                                     |
| ...                       | ...                                           |                           |                                     |
| 32                        | 2 layers: TPMI=13                             |                           |                                     |
| 33                        | 3 layers: TPMI=2                              |                           |                                     |
| 34                        | 4 layers: TPMI=1                              |                           |                                     |
| 35                        | 4 layers: TPMI=2                              |                           |                                     |
| 36-63                     | Reserved                                      |                           |                                     |

**Table 7.3.1.1.2-2C: Second precoding information, for 4 antenna ports, if transform precoder is disabled, *maxRank* = 2 or 3 or 4, and *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower***

| Bit field mapped to index | <i>codebookSubset</i> = <i>fullyAndPartialAndNonCoherent</i> | Bit field mapped to index | <i>codebookSubset</i> = <i>partialAndNonCoherent</i> | Bit field mapped to index | <i>codebookSubset</i> = <i>nonCoherent</i> |
|---------------------------|--------------------------------------------------------------|---------------------------|------------------------------------------------------|---------------------------|--------------------------------------------|
| 0                         | 1 layer: TPMI=0                                              | 0                         | 1 layer: TPMI=0                                      | 0                         | 1 layer: TPMI=0                            |
| ...                       | ...                                                          | ...                       | ...                                                  | ...                       | ...                                        |
| 27                        | 1 layer: TPMI=27                                             | 11                        | 1 layer: TPMI=11                                     | 3                         | 1 layer: TPMI=3                            |
| 28-31                     | 1 layer: reserved                                            | 12-15                     | 1 layer: reserved                                    | 4-7                       | 1 layer: reserved                          |
| 0                         | 2 layers: TPMI=0                                             | 0                         | 2 layers: TPMI=0                                     | 0                         | 2 layers: TPMI=0                           |
| ...                       | ...                                                          | ...                       | ...                                                  | ...                       | ...                                        |
| 21                        | 2 layers: TPMI=21                                            | 13                        | 2 layers: TPMI=13                                    | 5                         | 2 layers: TPMI=5                           |
| 22-31                     | 2 layers: reserved                                           | 14-15                     | 2 layers: reserved                                   | 6-7                       | 2 layers: reserved                         |
| 0                         | 3 layers: TPMI=0                                             | 0                         | 3 layers: TPMI=0                                     | 0                         | 3 layers: TPMI=0                           |
| ...                       | ...                                                          | ...                       | ...                                                  | 1-7                       | 3 layers: reserved                         |
| 6                         | 3 layers: TPMI=6                                             | 2                         | 3 layers: TPMI=2                                     | 0                         | 4 layers: TPMI=0                           |
| 7-31                      | 3 layers: reserved                                           | 3-15                      | 3 layers: reserved                                   | 1-7                       | 4 layers: reserved                         |
| 0                         | 4 layers: TPMI=0                                             | 0                         | 4 layers: TPMI=0                                     |                           |                                            |
| ...                       | ...                                                          | ...                       | ...                                                  |                           |                                            |
| 4                         | 4 layers: TPMI=4                                             | 2                         | 4 layers: TPMI=2                                     |                           |                                            |
| 5-31                      | 4 layers: reserved                                           | 3-15                      | 4 layers: reserved                                   |                           |                                            |

**Table 7.3.1.1.2-2D: Second precoding information for 4 antenna ports, if transform precoder is disabled, *maxRank* = 2, and *ul-FullPowerTransmission* = *fullpowerMode1***

| Bit field mapped to index | <i>codebookSubset</i> = <i>partialAndNonCoherent</i> | Bit field mapped to index | <i>codebookSubset</i> = <i>nonCoherent</i> |
|---------------------------|------------------------------------------------------|---------------------------|--------------------------------------------|
| 0                         | 1 layer: TPMI=0                                      | 0                         | 1 layer: TPMI=0                            |
| ...                       | ...                                                  | ...                       | ...                                        |
| 14                        | 1 layer: TPMI=14                                     | 3                         | 1 layer: TPMI=3                            |
| 15                        | 1 layer: TPMI=15                                     | 4                         | 1 layer: TPMI=13                           |
| 0                         | 2 layers: TPMI=0                                     | 5-7                       | 1 layer: reserved                          |
| ...                       | ...                                                  | 0                         | 2 layers: TPMI=0                           |
| 13                        | 2 layers: TPMI=13                                    | ...                       | ...                                        |
| 14-15                     | 2 layers: reserved                                   | 6                         | 2 layers: TPMI=6                           |
|                           |                                                      | 7                         | 2 layers: reserved                         |

**Table 7.3.1.1.2-2E: Second precoding information for 4 antenna ports, if transform precoder is disabled, *maxRank* = 3 or 4, and *ul-FullPowerTransmission* = *fullpowerMode1***

| Bit field mapped to index | <i>codebookSubset</i> = <i>partialAndNonCoherent</i> | Bit field mapped to index | <i>codebookSubset</i> = <i>nonCoherent</i> |
|---------------------------|------------------------------------------------------|---------------------------|--------------------------------------------|
| 0                         | 1 layer: TPMI=0                                      | 0                         | 1 layer: TPMI=0                            |
| ...                       | ...                                                  | ...                       | ...                                        |
| 14                        | 1 layer: TPMI=14                                     | 3                         | 1 layer: TPMI=3                            |
| 15                        | 1 layer: TPMI=15                                     | 4                         | 1 layer: TPMI=13                           |
| 0                         | 2 layers: TPMI=0                                     | 5-7                       | 1 layer: reserved                          |
| ...                       | ...                                                  | 0                         | 2 layers: TPMI=0                           |
| 13                        | 2 layers: TPMI=13                                    | ...                       | ...                                        |
| 14-15                     | 2 layers: reserved                                   | 6                         | 2 layers: TPMI=6                           |
| 0                         | 3 layers: TPMI=0                                     | 7                         | 2 layers: reserved                         |
| ...                       | ...                                                  | 0                         | 3 layers: TPMI=0                           |
| 2                         | 3 layers: TPMI=2                                     | 1                         | 3 layer: TPMI=1                            |
| 3-15                      | 3 layers: reserved                                   | 2-7                       | 3 layers: reserved                         |
| 0                         | 4 layers: TPMI=0                                     | 0                         | 4 layers: TPMI=0                           |
| ...                       | ...                                                  | 1-7                       | 4 layers: reserved                         |
| 2                         | 4 layers: TPMI=2                                     |                           |                                            |
| 3-15                      | 4 layers: reserved                                   |                           |                                            |

**Table 7.3.1.1.2-3: Precoding information and number of layers or Second Precoding information, for 4 antenna ports, if transform precoder is enabled and *ul-FullPowerTransmission* is either not configured or configured to *fullpowerMode2* or configured to *fullpower*, or if transform precoder is disabled, *maxRank* = 1, and *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower***

| Bit field mapped to index | <i>codebookSubset</i> = <i>fullyAndPartialAndNonCoherent</i> | Bit field mapped to index | <i>codebookSubset</i> = <i>partialAndNonCoherent</i> | Bit field mapped to index | <i>codebookSubset</i> = <i>nonCoherent</i> |
|---------------------------|--------------------------------------------------------------|---------------------------|------------------------------------------------------|---------------------------|--------------------------------------------|
| 0                         | 1 layer: TPMI=0                                              | 0                         | 1 layer: TPMI=0                                      | 0                         | 1 layer: TPMI=0                            |
| 1                         | 1 layer: TPMI=1                                              | 1                         | 1 layer: TPMI=1                                      | 1                         | 1 layer: TPMI=1                            |
| ...                       | ...                                                          | ...                       | ...                                                  | ...                       | ...                                        |
| 3                         | 1 layer: TPMI=3                                              | 3                         | 1 layer: TPMI=3                                      | 3                         | 1 layer: TPMI=3                            |
| 4                         | 1 layer: TPMI=4                                              | 4                         | 1 layer: TPMI=4                                      |                           |                                            |
| ...                       | ...                                                          | ...                       | ...                                                  |                           |                                            |
| 11                        | 1 layer: TPMI=11                                             | 11                        | 1 layer: TPMI=11                                     |                           |                                            |
| 12                        | 1 layers: TPMI=12                                            | 12-15                     | reserved                                             |                           |                                            |
| ...                       | ...                                                          |                           |                                                      |                           |                                            |
| 27                        | 1 layers: TPMI=27                                            |                           |                                                      |                           |                                            |
| 28-31                     | reserved                                                     |                           |                                                      |                           |                                            |

**Table 7.3.1.1.2-3A: Precoding information and number of layers or Second Precoding information, for 4 antenna ports, if transform precoder is enabled and *ul-FullPowerTransmission* = *fullpowerMode1*, or if transform precoder is disabled, *maxRank* = 1, and *ul-FullPowerTransmission* = *fullpowerMode1***

| Bit field mapped to index | <i>codebookSubset</i> = <i>partialAndNonCoherent</i> | Bit field mapped to index | <i>codebookSubset</i> = <i>nonCoherent</i> |
|---------------------------|------------------------------------------------------|---------------------------|--------------------------------------------|
| 0                         | 1 layer: TPMI=0                                      | 0                         | 1 layer: TPMI=0                            |
| 1                         | 1 layer: TPMI=1                                      | 1                         | 1 layer: TPMI=1                            |
| ...                       | ...                                                  | ...                       | ...                                        |
| 3                         | 1 layer: TPMI=3                                      | 3                         | 1 layer: TPMI=3                            |
| 4                         | 1 layer: TPMI=13                                     | 4                         | 1 layer: TPMI=13                           |
| 5                         | 1 layer: TPMI=4                                      | 5-7                       | Reserved                                   |
| ...                       | ...                                                  |                           |                                            |
| 13                        | 1 layer: TPMI=12                                     |                           |                                            |
| 14                        | 1 layer: TPMI=14                                     |                           |                                            |
| 15                        | 1 layer: TPMI=15                                     |                           |                                            |

**Table 7.3.1.1.2-4: Precoding information and number of layers, for 2 antenna ports, if transform precoder is disabled, *maxRank* = 2, and *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower***

| Bit field mapped to index | <i>codebookSubset</i> = <i>fullyAndPartialAndNonCoherent</i> | Bit field mapped to index | <i>codebookSubset</i> = <i>nonCoherent</i> |
|---------------------------|--------------------------------------------------------------|---------------------------|--------------------------------------------|
| 0                         | 1 layer: TPMI=0                                              | 0                         | 1 layer: TPMI=0                            |
| 1                         | 1 layer: TPMI=1                                              | 1                         | 1 layer: TPMI=1                            |
| 2                         | 2 layers: TPMI=0                                             | 2                         | 2 layers: TPMI=0                           |
| 3                         | 1 layer: TPMI=2                                              | 3                         | reserved                                   |
| 4                         | 1 layer: TPMI=3                                              |                           |                                            |
| 5                         | 1 layer: TPMI=4                                              |                           |                                            |
| 6                         | 1 layer: TPMI=5                                              |                           |                                            |
| 7                         | 2 layers: TPMI=1                                             |                           |                                            |
| 8                         | 2 layers: TPMI=2                                             |                           |                                            |
| 9-15                      | reserved                                                     |                           |                                            |



**Table 7.3.1.1.2-4A: Precoding information and number of layers, for 2 antenna ports, if transform precoder is disabled,  $maxRank = 2$ , and  $ul-FullPowerTransmission = fullpowerMode1$**

| Bit field mapped to index | <i>codebookSubset= nonCoherent</i> |
|---------------------------|------------------------------------|
| 0                         | 1 layer: TPMI=0                    |
| 1                         | 1 layer: TPMI=1                    |
| 2                         | 2 layers: TPMI=0                   |
| 3                         | 1 layer: TPMI=2                    |

**Table 7.3.1.1.2-4B: Second precoding information, for 2 antenna ports, if transform precoder is disabled,  $maxRank = 2$ , and  $ul-FullPowerTransmission$  is not configured or configured to *fullpowerMode2* or configured to *fullpower***

| Bit field mapped to index | <i>codebookSubset = fullyAndPartialAndNonCoherent</i> | Bit field mapped to index | <i>codebookSubset = nonCoherent</i> |
|---------------------------|-------------------------------------------------------|---------------------------|-------------------------------------|
| 0                         | 1 layer: TPMI=0                                       | 0                         | 1 layer: TPMI=0                     |
| 1                         | 1 layer: TPMI=1                                       | 1                         | 1 layer: TPMI=1                     |
| ...                       | ...                                                   | 0                         | 2 layers: TPMI=0                    |
| 5                         | 1 layer: TPMI=5                                       | 1                         | 2 layers: reserved                  |
| 6-7                       | 1 layer: reserved                                     |                           |                                     |
| 0                         | 2 layers: TPMI=0                                      |                           |                                     |
| ...                       | ...                                                   |                           |                                     |
| 2                         | 2 layers: TPMI=2                                      |                           |                                     |
| 3-7                       | 2 layers: reserved                                    |                           |                                     |

**Table 7.3.1.1.2-4C: Second precoding information, for 2 antenna ports, if transform precoder is disabled,  $maxRank = 2$ , and  $ul-FullPowerTransmission = fullpowerMode1$**

| Bit field mapped to index | <i>codebookSubset= nonCoherent</i> |
|---------------------------|------------------------------------|
| 0                         | 1 layer: TPMI=0                    |
| ...                       | ...                                |
| 2                         | 1 layer: TPMI=2                    |
| 3                         | 1 layer: reserved                  |
| 0                         | 2 layers: TPMI=0                   |
| 1-3                       | 2 layers: reserved                 |

**Table 7.3.1.1.2-5: Precoding information and number of layers or Second Precoding information, for 2 antenna ports, if transform precoder is enabled and  $ul-FullPowerTransmission$  is not configured or configured to *fullpowerMode2* or configured to *fullpower*, or if transform precoder is disabled,  $maxRank = 1$ , and  $ul-FullPowerTransmission$  is not configured or configured to *fullpowerMode2* or configured to *fullpower***

| Bit field mapped to index | <i>codebookSubset = fullyAndPartialAndNonCoherent</i> | Bit field mapped to index | <i>codebookSubset = nonCoherent</i> |
|---------------------------|-------------------------------------------------------|---------------------------|-------------------------------------|
| 0                         | 1 layer: TPMI=0                                       | 0                         | 1 layer: TPMI=0                     |
| 1                         | 1 layer: TPMI=1                                       | 1                         | 1 layer: TPMI=1                     |
| 2                         | 1 layer: TPMI=2                                       |                           |                                     |
| 3                         | 1 layer: TPMI=3                                       |                           |                                     |
| 4                         | 1 layer: TPMI=4                                       |                           |                                     |
| 5                         | 1 layer: TPMI=5                                       |                           |                                     |
| 6-7                       | reserved                                              |                           |                                     |

**Table 7.3.1.1.2-5A: Precoding information and number of layers, for 2 antenna ports or Second Precoding information, if transform precoder is enabled and *ul-FullPowerTransmission* = *fullpowerMode1*, or if transform precoder is disabled, *maxRank* = 1, and *ul-FullPowerTransmission* = *fullpowerMode1***

| Bit field mapped to index | <i>codebookSubset= nonCoherent</i> |
|---------------------------|------------------------------------|
| 0                         | 1 layer: TPMI=0                    |
| 1                         | 1 layer: TPMI=1                    |
| 2                         | 1 layer: TPMI=2                    |
| 3                         | Reserved                           |

**Table 7.3.1.1.2-6: Antenna port(s), transform precoder is enabled, *dmrs-Type*=1, *maxLength*=1, except that *dmrs-UplinkTransformPrecoding* and *tp-pi2BPSK* are both configured and  $\pi/2$ -BPSK modulation is used**

| Value | Number of DMRS CDM group(s) without data | DMRS port(s) |
|-------|------------------------------------------|--------------|
| 0     | 2                                        | 0            |
| 1     | 2                                        | 1            |
| 2     | 2                                        | 2            |
| 3     | 2                                        | 3            |

**Table 7.3.1.1.2-6A: Antenna port(s), transform precoder is enabled, *dmrs-UplinkTransformPrecoding* and *tp-pi2BPSK* are both configured,  $\pi/2$ -BPSK modulation is used, *dmrs-Type*=1, *maxLength*=1**

| Value | Number of DMRS CDM group(s) without data | DMRS port(s)    |
|-------|------------------------------------------|-----------------|
| 0     | 2                                        | 0, $n_{SCID}=0$ |
| 1     | 2                                        | 0, $n_{SCID}=1$ |
| 2     | 2                                        | 2, $n_{SCID}=0$ |
| 3     | 2                                        | 2, $n_{SCID}=1$ |

**Table 7.3.1.1.2-7: Antenna port(s), transform precoder is enabled, *dmrs-Type*=1, *maxLength*=2, except that *dmrs-UplinkTransformPrecoding* and *tp-pi2BPSK* are both configured and  $\pi/2$ -BPSK modulation is used**

| Value | Number of DMRS CDM group(s) without data | DMRS port(s) | Number of front-load symbols |
|-------|------------------------------------------|--------------|------------------------------|
| 0     | 2                                        | 0            | 1                            |
| 1     | 2                                        | 1            | 1                            |
| 2     | 2                                        | 2            | 1                            |
| 3     | 2                                        | 3            | 1                            |
| 4     | 2                                        | 0            | 2                            |
| 5     | 2                                        | 1            | 2                            |
| 6     | 2                                        | 2            | 2                            |
| 7     | 2                                        | 3            | 2                            |
| 8     | 2                                        | 4            | 2                            |
| 9     | 2                                        | 5            | 2                            |
| 10    | 2                                        | 6            | 2                            |
| 11    | 2                                        | 7            | 2                            |
| 12-15 | Reserved                                 | Reserved     | Reserved                     |

**Table 7.3.1.1.2-7A: Antenna port(s), transform precoder is enabled, *dmrs-UplinkTransformPrecoding* and *tp- $\pi$ 2BPSK* are both configured,  $\pi/2$ -BPSK modulation is used, *dmrs-Type*=1, *maxLength*=2**

| Value | Number of DMRS CDM group(s) without data | DMRS port(s)           | Number of front-load symbols |
|-------|------------------------------------------|------------------------|------------------------------|
| 0     | 2                                        | 0, $n_{\text{SCID}}=0$ | 1                            |
| 1     | 2                                        | 0, $n_{\text{SCID}}=1$ | 1                            |
| 2     | 2                                        | 2, $n_{\text{SCID}}=0$ | 1                            |
| 3     | 2                                        | 2, $n_{\text{SCID}}=1$ | 1                            |
| 4     | 2                                        | 0, $n_{\text{SCID}}=0$ | 2                            |
| 5     | 2                                        | 0, $n_{\text{SCID}}=1$ | 2                            |
| 6     | 2                                        | 2, $n_{\text{SCID}}=0$ | 2                            |
| 7     | 2                                        | 2, $n_{\text{SCID}}=1$ | 2                            |
| 8     | 2                                        | 4, $n_{\text{SCID}}=0$ | 2                            |
| 9     | 2                                        | 4, $n_{\text{SCID}}=1$ | 2                            |
| 10    | 2                                        | 6, $n_{\text{SCID}}=0$ | 2                            |
| 11    | 2                                        | 6, $n_{\text{SCID}}=1$ | 2                            |
| 12-15 | Reserved                                 | Reserved               | Reserved                     |

**Table 7.3.1.1.2-8: Antenna port(s), transform precoder is disabled, *dmrs-Type*=1, *maxLength*=1, rank = 1**

| Value | Number of DMRS CDM group(s) without data | DMRS port(s) |
|-------|------------------------------------------|--------------|
| 0     | 1                                        | 0            |
| 1     | 1                                        | 1            |
| 2     | 2                                        | 0            |
| 3     | 2                                        | 1            |
| 4     | 2                                        | 2            |
| 5     | 2                                        | 3            |
| 6-7   | Reserved                                 | Reserved     |

**Table 7.3.1.1.2-9: Antenna port(s), transform precoder is disabled, *dmrs-Type*=1, *maxLength*=1, rank = 2**

| Value | Number of DMRS CDM group(s) without data | DMRS port(s) |
|-------|------------------------------------------|--------------|
| 0     | 1                                        | 0,1          |
| 1     | 2                                        | 0,1          |
| 2     | 2                                        | 2,3          |
| 3     | 2                                        | 0,2          |
| 4-7   | Reserved                                 | Reserved     |

**Table 7.3.1.1.2-10: Antenna port(s), transform precoder is disabled, *dmrs-Type*=1, *maxLength*=1, rank = 3**

| Value | Number of DMRS CDM group(s) without data | DMRS port(s) |
|-------|------------------------------------------|--------------|
| 0     | 2                                        | 0-2          |
| 1-7   | Reserved                                 | Reserved     |

**Table 7.3.1.1.2-11: Antenna port(s), transform precoder is disabled, *dmrs-Type*=1, *maxLength*=1, rank = 4**

| Value | Number of DMRS CDM group(s) without data | DMRS port(s) |
|-------|------------------------------------------|--------------|
| 0     | 2                                        | 0-3          |
| 1-7   | Reserved                                 | Reserved     |

**Table 7.3.1.1.2-12: Antenna port(s), transform precoder is disabled, *dmrs-Type*=1, *maxLength*=2, rank = 1**

| Value | Number of DMRS CDM group(s) without data | DMRS port(s) | Number of front-load symbols |
|-------|------------------------------------------|--------------|------------------------------|
| 0     | 1                                        | 0            | 1                            |
| 1     | 1                                        | 1            | 1                            |
| 2     | 2                                        | 0            | 1                            |
| 3     | 2                                        | 1            | 1                            |
| 4     | 2                                        | 2            | 1                            |
| 5     | 2                                        | 3            | 1                            |
| 6     | 2                                        | 0            | 2                            |
| 7     | 2                                        | 1            | 2                            |
| 8     | 2                                        | 2            | 2                            |
| 9     | 2                                        | 3            | 2                            |
| 10    | 2                                        | 4            | 2                            |
| 11    | 2                                        | 5            | 2                            |
| 12    | 2                                        | 6            | 2                            |
| 13    | 2                                        | 7            | 2                            |
| 14-15 | Reserved                                 | Reserved     | Reserved                     |

**Table 7.3.1.1.2-13: Antenna port(s), transform precoder is disabled, *dmrs-Type*=1, *maxLength*=2, rank = 2**

| Value | Number of DMRS CDM group(s) without data | DMRS port(s) | Number of front-load symbols |
|-------|------------------------------------------|--------------|------------------------------|
| 0     | 1                                        | 0,1          | 1                            |
| 1     | 2                                        | 0,1          | 1                            |
| 2     | 2                                        | 2,3          | 1                            |
| 3     | 2                                        | 0,2          | 1                            |
| 4     | 2                                        | 0,1          | 2                            |
| 5     | 2                                        | 2,3          | 2                            |
| 6     | 2                                        | 4,5          | 2                            |
| 7     | 2                                        | 6,7          | 2                            |
| 8     | 2                                        | 0,4          | 2                            |
| 9     | 2                                        | 2,6          | 2                            |
| 10-15 | Reserved                                 | Reserved     | Reserved                     |

**Table 7.3.1.1.2-14: Antenna port(s), transform precoder is disabled, *dmrs-Type*=1, *maxLength*=2, rank = 3**

| Value | Number of DMRS CDM group(s) without data | DMRS port(s) | Number of front-load symbols |
|-------|------------------------------------------|--------------|------------------------------|
| 0     | 2                                        | 0-2          | 1                            |
| 1     | 2                                        | 0,1,4        | 2                            |
| 2     | 2                                        | 2,3,6        | 2                            |
| 3-15  | Reserved                                 | Reserved     | Reserved                     |

**Table 7.3.1.1.2-15: Antenna port(s), transform precoder is disabled, *dmrs-Type*=1, *maxLength*=2, rank = 4**

| Value | Number of DMRS CDM group(s) without data | DMRS port(s) | Number of front-load symbols |
|-------|------------------------------------------|--------------|------------------------------|
| 0     | 2                                        | 0-3          | 1                            |
| 1     | 2                                        | 0,1,4,5      | 2                            |
| 2     | 2                                        | 2,3,6,7      | 2                            |
| 3     | 2                                        | 0,2,4,6      | 2                            |
| 4-15  | Reserved                                 | Reserved     | Reserved                     |

**Table 7.3.1.1.2-16: Antenna port(s), transform precoder is disabled, *dmrs-Type*=2, *maxLength*=1, rank=1**

| Value | Number of DMRS CDM group(s) without data | DMRS port(s) |
|-------|------------------------------------------|--------------|
| 0     | 1                                        | 0            |
| 1     | 1                                        | 1            |
| 2     | 2                                        | 0            |
| 3     | 2                                        | 1            |
| 4     | 2                                        | 2            |
| 5     | 2                                        | 3            |
| 6     | 3                                        | 0            |
| 7     | 3                                        | 1            |
| 8     | 3                                        | 2            |
| 9     | 3                                        | 3            |
| 10    | 3                                        | 4            |
| 11    | 3                                        | 5            |
| 12-15 | Reserved                                 | Reserved     |

**Table 7.3.1.1.2-17: Antenna port(s), transform precoder is disabled, *dmrs-Type*=2, *maxLength*=1, rank=2**

| Value | Number of DMRS CDM group(s) without data | DMRS port(s) |
|-------|------------------------------------------|--------------|
| 0     | 1                                        | 0,1          |
| 1     | 2                                        | 0,1          |
| 2     | 2                                        | 2,3          |
| 3     | 3                                        | 0,1          |
| 4     | 3                                        | 2,3          |
| 5     | 3                                        | 4,5          |
| 6     | 2                                        | 0,2          |
| 7-15  | Reserved                                 | Reserved     |

**Table 7.3.1.1.2-18: Antenna port(s), transform precoder is disabled, *dmrs-Type*=2, *maxLength*=1, rank=3**

| Value | Number of DMRS CDM group(s) without data | DMRS port(s) |
|-------|------------------------------------------|--------------|
| 0     | 2                                        | 0-2          |
| 1     | 3                                        | 0-2          |
| 2     | 3                                        | 3-5          |
| 3-15  | Reserved                                 | Reserved     |

**Table 7.3.1.1.2-19: Antenna port(s), transform precoder is disabled, *dmrs-Type*=2, *maxLength*=1, rank=4**

| Value | Number of DMRS CDM group(s) without data | DMRS port(s) |
|-------|------------------------------------------|--------------|
| 0     | 2                                        | 0-3          |
| 1     | 3                                        | 0-3          |
| 2-15  | Reserved                                 | Reserved     |

**Table 7.3.1.1.2-20: Antenna port(s), transform precoder is disabled, *dmrs-Type*=2, *maxLength*=2, rank=1**

| Value | Number of DMRS CDM group(s) without data | DMRS port(s) | Number of front-load symbols |
|-------|------------------------------------------|--------------|------------------------------|
| 0     | 1                                        | 0            | 1                            |
| 1     | 1                                        | 1            | 1                            |
| 2     | 2                                        | 0            | 1                            |
| 3     | 2                                        | 1            | 1                            |
| 4     | 2                                        | 2            | 1                            |
| 5     | 2                                        | 3            | 1                            |
| 6     | 3                                        | 0            | 1                            |
| 7     | 3                                        | 1            | 1                            |
| 8     | 3                                        | 2            | 1                            |
| 9     | 3                                        | 3            | 1                            |
| 10    | 3                                        | 4            | 1                            |
| 11    | 3                                        | 5            | 1                            |
| 12    | 3                                        | 0            | 2                            |
| 13    | 3                                        | 1            | 2                            |
| 14    | 3                                        | 2            | 2                            |
| 15    | 3                                        | 3            | 2                            |
| 16    | 3                                        | 4            | 2                            |
| 17    | 3                                        | 5            | 2                            |
| 18    | 3                                        | 6            | 2                            |
| 19    | 3                                        | 7            | 2                            |
| 20    | 3                                        | 8            | 2                            |
| 21    | 3                                        | 9            | 2                            |
| 22    | 3                                        | 10           | 2                            |
| 23    | 3                                        | 11           | 2                            |
| 24    | 1                                        | 0            | 2                            |
| 25    | 1                                        | 1            | 2                            |
| 26    | 1                                        | 6            | 2                            |
| 27    | 1                                        | 7            | 2                            |
| 28-31 | Reserved                                 | Reserved     | Reserved                     |

**Table 7.3.1.1.2-21: Antenna port(s), transform precoder is disabled, *dmrs-Type*=2, *maxLength*=2, rank=2**

| Value | Number of DMRS CDM group(s) without data | DMRS port(s) | Number of front-load symbols |
|-------|------------------------------------------|--------------|------------------------------|
| 0     | 1                                        | 0,1          | 1                            |
| 1     | 2                                        | 0,1          | 1                            |
| 2     | 2                                        | 2,3          | 1                            |
| 3     | 3                                        | 0,1          | 1                            |
| 4     | 3                                        | 2,3          | 1                            |
| 5     | 3                                        | 4,5          | 1                            |
| 6     | 2                                        | 0,2          | 1                            |
| 7     | 3                                        | 0,1          | 2                            |
| 8     | 3                                        | 2,3          | 2                            |
| 9     | 3                                        | 4,5          | 2                            |
| 10    | 3                                        | 6,7          | 2                            |
| 11    | 3                                        | 8,9          | 2                            |
| 12    | 3                                        | 10,11        | 2                            |
| 13    | 1                                        | 0,1          | 2                            |
| 14    | 1                                        | 6,7          | 2                            |
| 15    | 2                                        | 0,1          | 2                            |
| 16    | 2                                        | 2,3          | 2                            |
| 17    | 2                                        | 6,7          | 2                            |
| 18    | 2                                        | 8,9          | 2                            |
| 19-31 | Reserved                                 | Reserved     | Reserved                     |

**Table 7.3.1.1.2-22: Antenna port(s), transform precoder is disabled, *dmrs-Type*=2, *maxLength*=2, rank=3**

| Value | Number of DMRS CDM group(s) without data | DMRS port(s) | Number of front-load symbols |
|-------|------------------------------------------|--------------|------------------------------|
| 0     | 2                                        | 0-2          | 1                            |
| 1     | 3                                        | 0-2          | 1                            |
| 2     | 3                                        | 3-5          | 1                            |
| 3     | 3                                        | 0,1,6        | 2                            |
| 4     | 3                                        | 2,3,8        | 2                            |
| 5     | 3                                        | 4,5,10       | 2                            |
| 6-31  | Reserved                                 | Reserved     | Reserved                     |

**Table 7.3.1.1.2-23: Antenna port(s), transform precoder is disabled, *dmrs-Type*=2, *maxLength*=2, rank=4**

| Value | Number of DMRS CDM group(s) without data | DMRS port(s) | Number of front-load symbols |
|-------|------------------------------------------|--------------|------------------------------|
| 0     | 2                                        | 0-3          | 1                            |
| 1     | 3                                        | 0-3          | 1                            |
| 2     | 3                                        | 0,1,6,7      | 2                            |
| 3     | 3                                        | 2,3,8,9      | 2                            |
| 4     | 3                                        | 4,5,10,11    | 2                            |
| 5-31  | Reserved                                 | Reserved     | Reserved                     |

Table 7.3.1.1.2-24: SRS request

| Value of SRS request field | Triggered aperiodic SRS resource set(s) for DCI format 0_1, 0_2, 1_1, 1_2, and 2_3 configured with higher layer parameter <i>srs-TPC-PDCCH-Group</i> set to 'typeB'                                                                                                                                                                                                                                | Triggered aperiodic SRS resource set(s) for DCI format 2_3 configured with higher layer parameter <i>srs-TPC-PDCCH-Group</i> set to 'typeA'                                                                                                                             |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 00                         | No aperiodic SRS resource set triggered                                                                                                                                                                                                                                                                                                                                                            | No aperiodic SRS resource set triggered                                                                                                                                                                                                                                 |
| 01                         | <p>SRS resource set(s) configured by <i>SRS-ResourceSet</i> with higher layer parameter <i>aperiodicSRS-ResourceTrigger</i> set to 1 or an entry in <i>aperiodicSRS-ResourceTriggerList</i> set to 1</p> <p>SRS resource set(s) configured by <i>SRS-PosResourceSet</i> with an entry in <i>aperiodicSRS-ResourceTriggerList</i> set to 1 when triggered by DCI formats 0_1, 0_2, 1_1, and 1_2</p> | SRS resource set(s) configured with higher layer parameter <i>usage</i> in <i>SRS-ResourceSet</i> set to 'antennaSwitching' and <i>resourceType</i> in <i>SRS-ResourceSet</i> set to 'aperiodic' for a 1 <sup>st</sup> set of serving cells configured by higher layers |
| 10                         | <p>SRS resource set(s) configured by <i>SRS-ResourceSet</i> with higher layer parameter <i>aperiodicSRS-ResourceTrigger</i> set to 2 or an entry in <i>aperiodicSRS-ResourceTriggerList</i> set to 2</p> <p>SRS resource set(s) configured by <i>SRS-PosResourceSet</i> with an entry in <i>aperiodicSRS-ResourceTriggerList</i> set to 2 when triggered by DCI formats 0_1, 0_2, 1_1, and 1_2</p> | SRS resource set(s) configured with higher layer parameter <i>usage</i> in <i>SRS-ResourceSet</i> set to 'antennaSwitching' and <i>resourceType</i> in <i>SRS-ResourceSet</i> set to 'aperiodic' for a 2 <sup>nd</sup> set of serving cells configured by higher layers |
| 11                         | <p>SRS resource set(s) configured by <i>SRS-ResourceSet</i> with higher layer parameter <i>aperiodicSRS-ResourceTrigger</i> set to 3 or an entry in <i>aperiodicSRS-ResourceTriggerList</i> set to 3</p> <p>SRS resource set(s) configured by <i>SRS-PosResourceSet</i> with an entry in <i>aperiodicSRS-ResourceTriggerList</i> set to 3 when triggered by DCI formats 0_1, 0_2, 1_1, and 1_2</p> | SRS resource set(s) configured with higher layer parameter <i>usage</i> in <i>SRS-ResourceSet</i> set to 'antennaSwitching' and <i>resourceType</i> in <i>SRS-ResourceSet</i> set to 'aperiodic' for a 3 <sup>rd</sup> set of serving cells configured by higher layers |

Table 7.3.1.1.2-25: PTRS-DMRS association or Second PTRS-DMRS association for UL PTRS port 0

| Value | DMRS port                           |
|-------|-------------------------------------|
| 0     | 1 <sup>st</sup> scheduled DMRS port |
| 1     | 2 <sup>nd</sup> scheduled DMRS port |
| 2     | 3 <sup>rd</sup> scheduled DMRS port |
| 3     | 4 <sup>th</sup> scheduled DMRS port |



**Table 7.3.1.1.2-25A: PTRS-DMRS association for UL PTRS port 0 or for the actual UL PT-RS port**

| Value of MSB | DMRS port                                                                                                                                 |  | Value of LSB | DMRS port                                                                                                              |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------|--|--------------|------------------------------------------------------------------------------------------------------------------------|
| 0            | 1 <sup>st</sup> scheduled DMRS port corresponding to SRS resource indicator field and/or Precoding information and number of layers field |  | 0            | 1st scheduled DMRS port corresponding to Second SRS resource indicator field and/or Second Precoding information field |
| 1            | 2 <sup>nd</sup> scheduled DMRS port corresponding to SRS resource indicator field and/or Precoding information and number of layers field |  | 1            | 2nd scheduled DMRS port corresponding to Second SRS resource indicator field and/or Second Precoding information field |

**Table 7.3.1.1.2-26: PTRS-DMRS association or Second PTRS-DMRS association for UL PTRS ports 0 and 1**

| Value of MSB | DMRS port                                          |  | Value of LSB | DMRS port                                          |
|--------------|----------------------------------------------------|--|--------------|----------------------------------------------------|
| 0            | 1 <sup>st</sup> DMRS port which shares PTRS port 0 |  | 0            | 1 <sup>st</sup> DMRS port which shares PTRS port 1 |
| 1            | 2 <sup>nd</sup> DMRS port which shares PTRS port 0 |  | 1            | 2 <sup>nd</sup> DMRS port which shares PTRS port 1 |

**Table 7.3.1.1.2-27: void****Table 7.3.1.1.2-28: SRI indication or Second SRI indication, for non-codebook based PUSCH transmission,  $L_{\max} = 1$** 

| Bit field mapped to index | SRI(s), $N_{\text{SRS}} = 2$ | Bit field mapped to index | SRI(s), $N_{\text{SRS}} = 3$ | Bit field mapped to index | SRI(s), $N_{\text{SRS}} = 4$ |
|---------------------------|------------------------------|---------------------------|------------------------------|---------------------------|------------------------------|
| 0                         | 0                            | 0                         | 0                            | 0                         | 0                            |
| 1                         | 1                            | 1                         | 1                            | 1                         | 1                            |
|                           |                              | 2                         | 2                            | 2                         | 2                            |
|                           |                              | 3                         | reserved                     | 3                         | 3                            |

**Table 7.3.1.1.2-29: SRI indication for non-codebook based PUSCH transmission,  $L_{\max} = 2$** 

| Bit field mapped to index | SRI(s), $N_{\text{SRS}} = 2$ | Bit field mapped to index | SRI(s), $N_{\text{SRS}} = 3$ | Bit field mapped to index | SRI(s), $N_{\text{SRS}} = 4$ |
|---------------------------|------------------------------|---------------------------|------------------------------|---------------------------|------------------------------|
| 0                         | 0                            | 0                         | 0                            | 0                         | 0                            |
| 1                         | 1                            | 1                         | 1                            | 1                         | 1                            |
| 2                         | 0,1                          | 2                         | 2                            | 2                         | 2                            |
| 3                         | reserved                     | 3                         | 0,1                          | 3                         | 3                            |
|                           |                              | 4                         | 0,2                          | 4                         | 0,1                          |
|                           |                              | 5                         | 1,2                          | 5                         | 0,2                          |
|                           |                              | 6-7                       | reserved                     | 6                         | 0,3                          |
|                           |                              |                           |                              | 7                         | 1,2                          |
|                           |                              |                           |                              | 8                         | 1,3                          |
|                           |                              |                           |                              | 9                         | 2,3                          |
|                           |                              |                           |                              | 10-15                     | reserved                     |

**Table 7.3.1.1.2-29A: Second SRI indication for non-codebook based PUSCH transmission,  $L_{max} = 2$** 

| Bit field mapped to index | SRI(s), $N_{SRS} = 2$ | Bit field mapped to index | SRI(s), $N_{SRS} = 3$ | Bit field mapped to index | SRI(s), $N_{SRS} = 4$ |
|---------------------------|-----------------------|---------------------------|-----------------------|---------------------------|-----------------------|
| 0                         | 0                     | 0                         | 0                     | 0                         | 0                     |
| 1                         | 1                     | 1                         | 1                     | 1                         | 1                     |
| 0                         | 0,1                   | 2                         | 2                     | 2                         | 2                     |
| 1                         | 2 layers: reserved    | 3                         | 1 layer: reserved     | 3                         | 3                     |
|                           |                       | 0                         | 0,1                   | 4-7                       | 1 layer: reserved     |
|                           |                       | 1                         | 0,2                   | 0                         | 0,1                   |
|                           |                       | 2                         | 1,2                   | 1                         | 0,2                   |
|                           |                       | 3                         | 2 layers: reserved    | 2                         | 0,3                   |
|                           |                       |                           |                       | 3                         | 1,2                   |
|                           |                       |                           |                       | 4                         | 1,3                   |
|                           |                       |                           |                       | 5                         | 2,3                   |
|                           |                       |                           |                       | 6-7                       | 2 layers: reserved    |

**Table 7.3.1.1.2-30: SRI indication for non-codebook based PUSCH transmission,  $L_{max} = 3$** 

| Bit field mapped to index | SRI(s), $N_{SRS} = 2$ | Bit field mapped to index | SRI(s), $N_{SRS} = 3$ | Bit field mapped to index | SRI(s), $N_{SRS} = 4$ |
|---------------------------|-----------------------|---------------------------|-----------------------|---------------------------|-----------------------|
| 0                         | 0                     | 0                         | 0                     | 0                         | 0                     |
| 1                         | 1                     | 1                         | 1                     | 1                         | 1                     |
| 2                         | 0,1                   | 2                         | 2                     | 2                         | 2                     |
| 3                         | reserved              | 3                         | 0,1                   | 3                         | 3                     |
|                           |                       | 4                         | 0,2                   | 4                         | 0,1                   |
|                           |                       | 5                         | 1,2                   | 5                         | 0,2                   |
|                           |                       | 6                         | 0,1,2                 | 6                         | 0,3                   |
|                           |                       | 7                         | reserved              | 7                         | 1,2                   |
|                           |                       |                           |                       | 8                         | 1,3                   |
|                           |                       |                           |                       | 9                         | 2,3                   |
|                           |                       |                           |                       | 10                        | 0,1,2                 |
|                           |                       |                           |                       | 11                        | 0,1,3                 |
|                           |                       |                           |                       | 12                        | 0,2,3                 |
|                           |                       |                           |                       | 13                        | 1,2,3                 |
|                           |                       |                           |                       | 14-15                     | reserved              |

**Table 7.3.1.1.2-30A: Second SRI indication for non-codebook based PUSCH transmission,  $L_{max} = 3$** 

| Bit field mapped to index | SRI(s), $N_{SRS} = 2$ | Bit field mapped to index | SRI(s), $N_{SRS} = 3$ | Bit field mapped to index | SRI(s), $N_{SRS} = 4$ |
|---------------------------|-----------------------|---------------------------|-----------------------|---------------------------|-----------------------|
| 0                         | 0                     | 0                         | 0                     | 0                         | 0                     |
| 1                         | 1                     | 1                         | 1                     | 1                         | 1                     |
| 0                         | 0,1                   | 2                         | 2                     | 2                         | 2                     |
| 1                         | 2 layers: reserved    | 3                         | 1 layer: reserved     | 3                         | 3                     |
|                           |                       | 0                         | 0,1                   | 4-7                       | 1 layer: reserved     |
|                           |                       | 1                         | 0,2                   | 0                         | 0,1                   |
|                           |                       | 2                         | 1,2                   | 1                         | 0,2                   |
|                           |                       | 3                         | 2 layers: reserved    | 2                         | 0,3                   |
|                           |                       | 0                         | 0,1,2                 | 3                         | 1,2                   |
|                           |                       | 1-3                       | 3 layers: reserved    | 4                         | 1,3                   |
|                           |                       |                           |                       | 5                         | 2,3                   |
|                           |                       |                           |                       | 6-7                       | 2 layers: reserved    |
|                           |                       |                           |                       | 0                         | 0,1,2                 |
|                           |                       |                           |                       | 1                         | 0,1,3                 |
|                           |                       |                           |                       | 2                         | 0,2,3                 |
|                           |                       |                           |                       | 3                         | 1,2,3                 |
|                           |                       |                           |                       | 4-7                       | 3 layers: reserved    |

**Table 7.3.1.1.2-31: SRI indication for non-codebook based PUSCH transmission,  $L_{\max} = 4$** 

| Bit field mapped to index | SRI(s), $N_{\text{SRS}} = 2$ | Bit field mapped to index | SRI(s), $N_{\text{SRS}} = 3$ | Bit field mapped to index | SRI(s), $N_{\text{SRS}} = 4$ |
|---------------------------|------------------------------|---------------------------|------------------------------|---------------------------|------------------------------|
| 0                         | 0                            | 0                         | 0                            | 0                         | 0                            |
| 1                         | 1                            | 1                         | 1                            | 1                         | 1                            |
| 2                         | 0,1                          | 2                         | 2                            | 2                         | 2                            |
| 3                         | reserved                     | 3                         | 0,1                          | 3                         | 3                            |
|                           |                              | 4                         | 0,2                          | 4                         | 0,1                          |
|                           |                              | 5                         | 1,2                          | 5                         | 0,2                          |
|                           |                              | 6                         | 0,1,2                        | 6                         | 0,3                          |
|                           |                              | 7                         | reserved                     | 7                         | 1,2                          |
|                           |                              |                           |                              | 8                         | 1,3                          |
|                           |                              |                           |                              | 9                         | 2,3                          |
|                           |                              |                           |                              | 10                        | 0,1,2                        |
|                           |                              |                           |                              | 11                        | 0,1,3                        |
|                           |                              |                           |                              | 12                        | 0,2,3                        |
|                           |                              |                           |                              | 13                        | 1,2,3                        |
|                           |                              |                           |                              | 14                        | 0,1,2,3                      |
|                           |                              |                           |                              | 15                        | reserved                     |

**Table 7.3.1.1.2-31A: Second SRI indication for non-codebook based PUSCH transmission,  $L_{\max} = 4$** 

| Bit field mapped to index | SRI(s), $N_{\text{SRS}} = 2$ | Bit field mapped to index | SRI(s), $N_{\text{SRS}} = 3$ | Bit field mapped to index | SRI(s), $N_{\text{SRS}} = 4$ |
|---------------------------|------------------------------|---------------------------|------------------------------|---------------------------|------------------------------|
| 0                         | 0                            | 0                         | 0                            | 0                         | 0                            |
| 1                         | 1                            | 1                         | 1                            | 1                         | 1                            |
| 0                         | 0,1                          | 2                         | 2                            | 2                         | 2                            |
| 1                         | 2 layers: reserved           | 3                         | 1 layer: reserved            | 3                         | 3                            |
|                           |                              | 0                         | 0,1                          | 4-7                       | 1 layer: reserved            |
|                           |                              | 1                         | 0,2                          | 0                         | 0,1                          |
|                           |                              | 2                         | 1,2                          | 1                         | 0,2                          |
|                           |                              | 3                         | 2 layers: reserved           | 2                         | 0,3                          |
|                           |                              | 0                         | 0,1,2                        | 3                         | 1,2                          |
|                           |                              | 1-3                       | 3 layers: reserved           | 4                         | 1,3                          |
|                           |                              |                           |                              | 5                         | 2,3                          |
|                           |                              |                           |                              | 6-7                       | 2 layers: reserved           |
|                           |                              |                           |                              | 0                         | 0,1,2                        |
|                           |                              |                           |                              | 1                         | 0,1,3                        |
|                           |                              |                           |                              | 2                         | 0,2,3                        |
|                           |                              |                           |                              | 3                         | 1,2,3                        |
|                           |                              |                           |                              | 4-7                       | 3 layer: reserved            |
|                           |                              |                           |                              | 0                         | 0,1,2,3                      |
|                           |                              |                           |                              | 1-7                       | 4 layers: reserved           |

**Table 7.3.1.1.2-32: SRI indication or Second SRI indication, for codebook based PUSCH transmission, if *ul-FullPowerTransmission* is not configured, or *ul-FullPowerTransmission* = *fullpowerMode1*, or *ul-FullPowerTransmission* = *fullpowerMode2*, or *ul-FullPowerTransmission* = *fullpower* and  $N_{\text{SRS}} = 2$** 

| Bit field mapped to index | SRI(s), $N_{\text{SRS}} = 2$ |
|---------------------------|------------------------------|
| 0                         | 0                            |
| 1                         | 1                            |

**Table 7.3.1.1.2-32A: SRI indication or Second SRI indication, for codebook based PUSCH transmission, if *ul-FullPowerTransmission* = *fullpowerMode2* and  $N_{SRS} = 3$**

| Bit field mapped to index | SRI(s), $N_{SRS} = 3$ |
|---------------------------|-----------------------|
| 0                         | 0                     |
| 1                         | 1                     |
| 2                         | 2                     |
| 3                         | Reserved              |

**Table 7.3.1.1.2-32B: SRI indication or Second SRI indication, for codebook based PUSCH transmission, if *ul-FullPowerTransmission* = *fullpowerMode2* and  $N_{SRS} = 4$**

| Bit field mapped to index | SRI(s), $N_{SRS} = 4$ |
|---------------------------|-----------------------|
| 0                         | 0                     |
| 1                         | 1                     |
| 2                         | 2                     |
| 3                         | 3                     |

**Table 7.3.1.1.2-33: Joint indication of minimum applicable scheduling offset K0/K2**

| Bit field mapped to index | Minimum applicable K0 for the active DL BWP, if <i>minimumSchedulingOffsetK0</i> is configured for the DL BWP                        | Minimum applicable K2 for the active UL BWP, if <i>minimumSchedulingOffsetK2</i> is configured for the UL BWP                        |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| 0                         | The first value configured by <i>minimumSchedulingOffsetK0</i> for the active DL BWP                                                 | The first value configured by <i>minimumSchedulingOffsetK2</i> for the active UL BWP                                                 |
| 1                         | The second value configured by <i>minimumSchedulingOffsetK0</i> for the active DL BWP if the second value is configured; 0 otherwise | The second value configured by <i>minimumSchedulingOffsetK2</i> for the active UL BWP if the second value is configured; 0 otherwise |

**Table 7.3.1.1.2-34: Redundancy version**

| Value of the Redundancy version field | Value of $rv_{id}$ to be applied |
|---------------------------------------|----------------------------------|
| 0                                     | 0                                |
| 1                                     | 2                                |

**Table 7.3.1.1.2-35: Allowed entries for DCI format 0\_1 and DCI format 0\_2, configured by higher layer parameter *ul-AccessConfigListDCI-0-1* and *ul-AccessConfigListDCI-0-2*, respectively, in frequency range 1**

| Entry index | Channel Access Type                                            | The CP extension T <sub>ext</sub> index defined in Clause 5.3.1 of [4, 38.211] | CAPC |
|-------------|----------------------------------------------------------------|--------------------------------------------------------------------------------|------|
| 0           | Type2C-ULChannelAccess defined in [clause 4.2.1.2.3 in 37.213] | 0                                                                              | 1    |
| 1           | Type2C-ULChannelAccess defined in [clause 4.2.1.2.3 in 37.213] | 0                                                                              | 2    |
| 2           | Type2C-ULChannelAccess defined in [clause 4.2.1.2.3 in 37.213] | 0                                                                              | 3    |
| 3           | Type2C-ULChannelAccess defined in [clause 4.2.1.2.3 in 37.213] | 0                                                                              | 4    |
| 4           | Type2C-ULChannelAccess defined in [clause 4.2.1.2.3 in 37.213] | 2                                                                              | 1    |
| 5           | Type2C-ULChannelAccess defined in [clause 4.2.1.2.3 in 37.213] | 2                                                                              | 2    |
| 6           | Type2C-ULChannelAccess defined in [clause 4.2.1.2.3 in 37.213] | 2                                                                              | 3    |
| 7           | Type2C-ULChannelAccess defined in [clause 4.2.1.2.3 in 37.213] | 2                                                                              | 4    |
| 8           | Type2B-ULChannelAccess defined in [clause 4.2.1.2.2 in 37.213] | 0                                                                              | 1    |
| 9           | Type2B-ULChannelAccess defined in [clause 4.2.1.2.2 in 37.213] | 0                                                                              | 2    |
| 10          | Type2B-ULChannelAccess defined in [clause 4.2.1.2.2 in 37.213] | 0                                                                              | 3    |
| 11          | Type2B-ULChannelAccess defined in [clause 4.2.1.2.2 in 37.213] | 0                                                                              | 4    |
| 12          | Type2B-ULChannelAccess defined in [clause 4.2.1.2.2 in 37.213] | 2                                                                              | 1    |
| 13          | Type2B-ULChannelAccess defined in [clause 4.2.1.2.2 in 37.213] | 2                                                                              | 2    |
| 14          | Type2B-ULChannelAccess defined in [clause 4.2.1.2.2 in 37.213] | 2                                                                              | 3    |
| 15          | Type2B-ULChannelAccess defined in [clause 4.2.1.2.2 in 37.213] | 2                                                                              | 4    |
| 16          | Type2A-ULChannelAccess defined in [clause 4.2.1.2.1 in 37.213] | 0                                                                              | 1    |
| 17          | Type2A-ULChannelAccess defined in [clause 4.2.1.2.1 in 37.213] | 0                                                                              | 2    |
| 18          | Type2A-ULChannelAccess defined in [clause 4.2.1.2.1 in 37.213] | 0                                                                              | 3    |
| 19          | Type2A-ULChannelAccess defined in [clause 4.2.1.2.1 in 37.213] | 0                                                                              | 4    |
| 20          | Type2A-ULChannelAccess defined in [clause 4.2.1.2.1 in 37.213] | 1                                                                              | 1    |
| 21          | Type2A-ULChannelAccess defined in [clause 4.2.1.2.1 in 37.213] | 1                                                                              | 2    |
| 22          | Type2A-ULChannelAccess defined in [clause 4.2.1.2.1 in 37.213] | 1                                                                              | 3    |
| 23          | Type2A-ULChannelAccess defined in [clause 4.2.1.2.1 in 37.213] | 1                                                                              | 4    |
| 24          | Type2A-ULChannelAccess defined in [clause 4.2.1.2.1 in 37.213] | 3                                                                              | 1    |
| 25          | Type2A-ULChannelAccess defined in [clause 4.2.1.2.1 in 37.213] | 3                                                                              | 2    |
| 26          | Type2A-ULChannelAccess defined in [clause 4.2.1.2.1 in 37.213] | 3                                                                              | 3    |
| 27          | Type2A-ULChannelAccess defined in [clause 4.2.1.2.1 in 37.213] | 3                                                                              | 4    |
| 28          | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 0                                                                              | 1    |
| 29          | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 0                                                                              | 2    |
| 30          | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 0                                                                              | 3    |
| 31          | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 0                                                                              | 4    |
| 32          | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 1                                                                              | 1    |
| 33          | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 1                                                                              | 2    |
| 34          | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 1                                                                              | 3    |
| 35          | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 1                                                                              | 4    |
| 36          | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 2                                                                              | 1    |
| 37          | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 2                                                                              | 2    |
| 38          | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 2                                                                              | 3    |
| 39          | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 2                                                                              | 4    |
| 40          | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 3                                                                              | 1    |
| 41          | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 3                                                                              | 2    |
| 42          | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 3                                                                              | 3    |
| 43          | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 3                                                                              | 4    |

**Table 7.3.1.1.2-35A: Allowed entries for DCI format 0\_1 and DCI format 0\_2, configured by higher layer parameter *ul-AccessConfigListDCI-0-1* in frequency range 2-2**

| Entry index | Channel Access Type                                     |
|-------------|---------------------------------------------------------|
| 0           | Type 1 channel access defined in clause 4.4.1 of 37.213 |
| 1           | Type 2 channel access defined in clause 4.4.2 of 37.213 |
| 2           | Type 3 channel access defined in clause 4.4.3 of 37.213 |

**Table 7.3.1.1.2-36: SRS resource set indication**

| Bit field mapped to index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | SRS resource set indication                                                                                                                                                                                                                                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | SRS resource indicator field and Precoding information and number of layers field are associated with the first SRS resource set;<br>Second SRS resource indicator field and Second Precoding information field are reserved.                                    |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | SRS resource indicator field and Precoding information and number of layers field are associated with the second SRS resource set;<br>Second SRS resource indicator field and Second Precoding information field are reserved.                                   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | SRS resource indicator field and Precoding information and number of layers field are associated with the first SRS resource set;<br>Second SRS resource indicator field and Second Precoding information field are associated with the second SRS resource set. |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | SRS resource indicator field and Precoding information and number of layers field are associated with the first SRS resource set;<br>Second SRS resource indicator field and Second Precoding information field are associated with the second SRS resource set. |
| <p>NOTE 1: The first and the second SRS resource sets are respectively the ones with lower and higher <i>srs-ResourceSetId</i> of the two SRS resources sets configured by higher layer parameter <i>srs-ResourceSetToAddModList</i> or <i>srs-ResourceSetToAddModListDCI-0-2</i>, and associated with the higher layer parameter <i>usage</i> of value 'nonCodeBook' if <i>txConfig=nonCodebook</i> or 'codebook' if <i>txConfig=codebook</i>. When only one SRS resource set is configured by higher layer parameter <i>srs-ResourceSetToAddModList</i> or <i>srs-ResourceSetToAddModListDCI-0-2</i>, and associated with the higher layer parameter <i>usage</i> of value 'codebook' or 'nonCodeBook' respectively, the first SRS resource set is the SRS resource set. The association of the first and second SRS resource sets to PUSCH repetitions for each bit field index value is as defined in Clause 6.1.2.1 of [6, TS 38.214].</p> <p>NOTE 2: For DCI format 0_2, the first and second SRS resource sets configured by higher layer parameter <i>srs-ResourceSetToAddModListDCI-0-2</i> are composed of the first <math>N_{sRS,0,2}</math> SRS resources together with other configurations in the first and second SRS resource sets configured by higher layer parameter <i>srs-ResourceSetToAddModList</i>, if any, and associated with the higher layer parameter <i>usage</i> of value 'codebook' or 'nonCodeBook', respectively, except for the higher layer parameters '<i>srs-ResourceSetId</i>' and '<i>srs-ResourceSetList</i>'.</p> |                                                                                                                                                                                                                                                                  |

Table 7.3.1.1.2-37: SRS offset indicator

| Bit field mapped to index | Available slot offset, K=2                                                                                                   | Bit field mapped to index | Available slot offset, K=3                                                                                                   | Bit field mapped to index | Available slot offset, K=4                                                                                                   |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------|---------------------------|------------------------------------------------------------------------------------------------------------------------------|---------------------------|------------------------------------------------------------------------------------------------------------------------------|
| 0                         | The 1 <sup>st</sup> entry in <i>availableSlotOffsetList</i> , if configured for the aperiodic SRS resource set; 0, otherwise | 0                         | The 1 <sup>st</sup> entry in <i>availableSlotOffsetList</i> , if configured for the aperiodic SRS resource set; 0, otherwise | 0                         | The 1 <sup>st</sup> entry in <i>availableSlotOffsetList</i> , if configured for the aperiodic SRS resource set; 0, otherwise |
| 1                         | The 2 <sup>nd</sup> entry in <i>availableSlotOffsetList</i> , if configured for the aperiodic SRS resource set; 0, otherwise | 1                         | The 2 <sup>nd</sup> entry in <i>availableSlotOffsetList</i> , if configured for the aperiodic SRS resource set; 0, otherwise | 1                         | The 2 <sup>nd</sup> entry in <i>availableSlotOffsetList</i> , if configured for the aperiodic SRS resource set; 0, otherwise |
|                           |                                                                                                                              | 2                         | The 3 <sup>rd</sup> entry in <i>availableSlotOffsetList</i> , if configured for the aperiodic SRS resource set; 0, otherwise | 2                         | The 3 <sup>rd</sup> entry in <i>availableSlotOffsetList</i> , if configured for the aperiodic SRS resource set; 0, otherwise |
|                           |                                                                                                                              | 3                         | Reserved                                                                                                                     | 3                         | The 4 <sup>th</sup> entry in <i>availableSlotOffsetList</i> , if configured for the aperiodic SRS resource set; 0, otherwise |

### 7.3.1.1.3 Format 0\_2

DCI format 0\_2 is used for the scheduling of PUSCH in one cell.

The following information is transmitted by means of the DCI format 0\_2 with CRC scrambled by C-RNTI or CS-RNTI or SP-CSI-RNTI or MCS-C-RNTI:

- Identifier for DCI formats – 1 bit
  - The value of this bit field is always set to 0, indicating an UL DCI format
- Carrier indicator – 0, 1, 2 or 3 bits determined by higher layer parameter *carrierIndicatorSizeDCI-0-2*, as defined in Clause 10.1 of [5, TS38.213]. This field is reserved when this format is carried by PDCCH on the primary cell and the UE is configured for scheduling on the primary cell from an SCell, with the same number of bits as that in this format carried by PDCCH on the SCell for scheduling on the primary cell.
- UL/SUL indicator – 0 bit for UEs not configured with *supplementaryUplink* in *ServingCellConfig* in the cell or UEs configured with *supplementaryUplink* in *ServingCellConfig* in the cell but only one carrier in the cell is configured for PUSCH transmission; otherwise, 1 bit as defined in Table 7.3.1.1.1-1.
- Bandwidth part indicator – 0, 1 or 2 bits as determined by the number of UL BWPs  $n_{BWP,RRC}$  configured by higher layers, excluding the initial UL bandwidth part. The bitwidth for this field is determined as  $\lceil \log_2(n_{BWP}) \rceil$  bits, where
  - $n_{BWP} = n_{BWP,RRC} + 1$  if  $n_{BWP,RRC} \leq 3$ , in which case the bandwidth part indicator is equivalent to the ascending order of the higher layer parameter *BWP-Id*;
  - otherwise  $n_{BWP} = n_{BWP,RRC}$ , in which case the bandwidth part indicator is defined in Table 7.3.1.1.2-1;

If a UE does not support active BWP change via DCI, the UE ignores this bit field.

- Frequency domain resource assignment – number of bits determined by the following:
  - $N_{RBG}$  bits if only resource allocation type 0 is configured, where  $N_{RBG}$  is defined in Clause 6.1.2.2.1 of [6, TS 38.214]

- $\lceil \log_2(N_{RBG,K1}(N_{RBG,K1} + 1)/2) \rceil$  bits if only resource allocation type 1 is configured, or  $\max(\lceil \log_2(N_{RBG,K1}(N_{RBG,K1} + 1)/2) \rceil, N_{RBG}) + 1$  bits if *resourceAllocationDCI-0-2-r16* is configured as 'dynamicSwitch', where  $N_{RBG,K1} = \lceil (N_{RB}^{UL,BWP} + (N_{UL,BWP}^{start} \bmod K1)) / K1 \rceil$ ,  $N_{RB}^{UL,BWP}$  is the size of the active UL bandwidth part,  $N_{UL,BWP}^{start}$  is defined as in clause 4.4.4.4 of [4, TS 38.211] and  $K1$  is given by higher layer parameter *resourceAllocationType1GranularityDCI-0-2*. If the higher layer parameter *resourceAllocationType1GranularityDCI-0-2* is not configured,  $K1$  is equal to 1.
- If *resourceAllocationDCI-0-2-r16* is configured as 'dynamicSwitch', the MSB bit is used to indicate resource allocation type 0 or resource allocation type 1, where the bit value of 0 indicates resource allocation type 0 and the bit value of 1 indicates resource allocation type 1.
- For resource allocation type 0, the  $N_{RBG}$  LSBs provide the resource allocation as defined in Clause 6.1.2.2.1 of [6, TS 38.214].
- For resource allocation type 1, the  $\lceil \log_2(N_{RBG,K1}(N_{RBG,K1} + 1)/2) \rceil$  LSBs provide the resource allocation as follows:
  - For PUSCH hopping with resource allocation type 1:
    - $N_{UL\_hop}$  MSB bits are used to indicate the frequency offset according to Clause 6.3 of [6, TS 38.214], where  $N_{UL\_hop} = 1$  if the higher layer parameter *frequencyHoppingOffsetListsDCI-0-2* contains two offset values and  $N_{UL\_hop} = 2$  if the higher layer parameter *frequencyHoppingOffsetListsDCI-0-2* contains four offset values
    - $\lceil \log_2(N_{RBG,K1}(N_{RBG,K1} + 1)/2) \rceil - N_{UL\_hop}$  bits provide the frequency domain resource allocation according to Clause 6.1.2.2.2 of [6, TS 38.214]
  - For non-PUSCH hopping with resource allocation type 1:
    - $\lceil \log_2(N_{RBG,K1}(N_{RBG,K1} + 1)/2) \rceil$  bits provide the frequency domain resource allocation according to Clause 6.1.2.2.2 of [6, TS 38.214]

If "Bandwidth part indicator" field indicates a bandwidth part other than the active bandwidth part and if *resourceAllocationDCI-0-2-r16* is configured as 'dynamicSwitch' for the indicated bandwidth part, the UE assumes resource allocation type 0 for the indicated bandwidth part if the bitwidth of the "Frequency domain resource assignment" field of the active bandwidth part is smaller than the bitwidth of the "Frequency domain resource assignment" field of the indicated bandwidth part.

- Time domain resource assignment – 0, 1, 2, 3, 4, 5 or 6 bits as defined in Clause 6.1.2.1 of [6, TS38.214]. The bitwidth for this field is determined as  $\lceil \log_2(I) \rceil$  bits, where  $I$  is the number of entries in the higher layer parameter *pusch-TimeDomainAllocationListDCI-0-2* if the higher layer parameter is configured, or  $I$  is the number of entries in the higher layer parameter *PUSCH-TimeDomainResourceAllocationList* if the higher layer parameter *PUSCH-TimeDomainResourceAllocationList* is configured and the higher layer parameter *pusch-TimeDomainAllocationListDCI-0-2* is not configured; otherwise  $I$  is the number of entries in the default table.
- Frequency hopping flag – 0 or 1 bit:
  - 0 bit if the higher layer parameter *frequencyHoppingDCI-0-2* is not configured;
  - 1 bit according to Table 7.3.1.1.1-3 otherwise, only applicable to resource allocation type 1, as defined in Clause 6.3 of [6, TS 38.214].
- Modulation and coding scheme – 5 bits as defined in Clause 6.1.4.1 of [6, TS 38.214]
- New data indicator – 1 bit
- Redundancy version – 0, 1 or 2 bits determined by higher layer parameter *numberOfBitsForRV-DCI-0-2*
  - If 0 bit is configured,  $rv_{id}$  to be applied is 0;
  - 1 bit according to Table 7.3.1.2.3-1;
  - 2 bits according to Table 7.3.1.1.1-2.



- HARQ process number – number of bits determined by the following:
  - 5 bits determined by higher layer parameter *harq-ProcessNumberSizeDCI-0-2-v1700* if configured;
  - otherwise 0, 1, 2, 3 or 4 bits determined by higher layer parameter *harq-ProcessNumberSizeDCI-0-2*
- Downlink assignment index – 0, 1, 2 or 4 bits
  - 0 bit if the higher layer parameter *downlinkAssignmentIndexDCI-0-2* is not configured;
  - 1, 2, 3, 4, 5 or 6 bits otherwise,
    - 1<sup>st</sup> downlink assignment index – 1 or 2 bits:
      - 1 bit for semi-static HARQ-ACK codebook for unicast and multicast if *pdsch-HARQ-ACK-Codebook = semiStatic* is configured for both unicast and multicast and the higher layer parameter *fdmed-ReceptionMulticast* is not configured; otherwise for semi-static HARQ-ACK codebook for unicast;
      - 2 bits for dynamic HARQ-ACK codebook for unicast.
    - 2<sup>nd</sup> downlink assignment index – 0 or 2 bits
      - 2 bits for dynamic HARQ-ACK codebook with two HARQ-ACK sub-codebooks for unicast;
      - 0 bit otherwise.
    - 3<sup>rd</sup> downlink assignment index – 0, 1 or 2 bits
      - 1 bit for semi-static HARQ-ACK codebook for multicast if the higher layer parameter *fdmed-ReceptionMulticast* is configured;
      - 2 bits for the dynamic HARQ-ACK codebook for multicast;
      - 0 bit otherwise.

When two HARQ-ACK codebooks are configured by *pdsch-HARQ-ACK-CodebookList* for the same serving cell and if higher layer parameter *priorityIndicatorDCI-0-2* is configured, if the bit width of the 1<sup>st</sup> or 2<sup>nd</sup> Downlink assignment index in DCI format 0\_2 for one HARQ-ACK codebook is not equal to that of the 1<sup>st</sup> or 2<sup>nd</sup> Downlink assignment index in DCI format 0\_2 for the other HARQ-ACK codebook, a number of most significant bits with value set to '0' are inserted to smaller 1<sup>st</sup> or 2<sup>nd</sup> Downlink assignment index until the bit width of the 1<sup>st</sup> or 2<sup>nd</sup> Downlink assignment index in DCI format 0\_2 for the two HARQ-ACK codebooks are the same.

When two HARQ-ACK codebooks are configured by *pdsch-HARQ-ACK-CodebookListMulticast* for the same serving cell and if higher layer parameter *priorityIndicatorDCI-0-2* is configured, if the bit width of the 3<sup>rd</sup> downlink assignment index in DCI format 0\_2 for one HARQ-ACK codebook is not equal to that of the 3<sup>rd</sup> downlink assignment index in DCI format 0\_2 for the other HARQ-ACK codebook, a number of most significant bits with value set to '0' are inserted to smaller 3<sup>rd</sup> downlink assignment index until the bit width of the 3<sup>rd</sup> downlink assignment index in DCI format 0\_2 for the two HARQ-ACK codebooks are the same.

- TPC command for scheduled PUSCH – 2 bits as defined in Clause 7.1.1 of [5, TS38.213]
- Second TPC command for scheduled PUSCH – 2 bits as defined in Clause 7.1.1 of [5, TS38.213] if higher layer parameter *SecondTPCFieldDCI-0-2* is configured; 0 bit otherwise.
- SRS resource set indicator – 0 or 2 bits
  - 2 bits according to Table 7.3.1.1.2-36 if
    - *txConfig = nonCodeBook*, and there are two SRS resource sets configured by *srs-ResourceSetToAddModListDCI-0-2* and associated with the *usage* of value 'nonCodeBook', or
    - *txConfig=codebook*, and there are two SRS resource sets configured by *srs-ResourceSetToAddModListDCI-0-2* and associated with *usage* of value 'codebook';
  - 0 bit otherwise.

- SRS resource indicator –  $\left\lceil \log_2 \left( \sum_{k=1}^{\min\{L_{max}, N_{SRS,0,2}\}} \binom{N_{SRS,0,2}}{k} \right) \right\rceil$  or  $\left\lceil \log_2 N_{SRS,0,2} \right\rceil$  bits, where  $N_{SRS,0,2}$  is the number of configured SRS resources in the SRS resource set indicated by SRS resource set indicator field if present; otherwise  $N_{SRS,0,2}$  is the number of configured SRS resources in the SRS resource set configured by higher layer parameter *srs-ResourceSetToAddModListDCI-0-2* and associated with the higher layer parameter *usage* of value 'codeBook' or 'nonCodeBook', where the SRS resource set is composed of the first  $N_{SRS,0,2}$  SRS resources together with other configurations in the SRS resource set, or in the SRS resource set with lower srs-ResourceSetId of two SRS resources sets, configured by higher layer parameter *srs-ResourceSetToAddModList*, if any, and associated with the higher layer parameter *usage* of value 'codeBook' or 'nonCodeBook', respectively, except for the higher layer parameters '*srs-ResourceSetId*' and '*srs-ResourceIdList*'
- $\left\lceil \log_2 \left( \sum_{k=1}^{\min\{L_{max}, N_{SRS,0,2}\}} \binom{N_{SRS,0,2}}{k} \right) \right\rceil$  bits according to Tables 7.3.1.1.2-28/29/30/31 if the higher layer parameter *txConfig* = *nonCodebook*, where  $N_{SRS,0,2}$  is the number of configured SRS resources in the SRS resource set indicated by SRS resource set indicator field if present, otherwise  $N_{SRS,0,2}$  is the number of configured SRS resources in the SRS resource set configured by higher layer parameter *srs-ResourceSetToAddModListDCI-0-2* and associated with the higher layer parameter *usage* of value 'nonCodeBook', where the SRS resource set is composed of the first  $N_{SRS,0,2}$  SRS resources together with other configurations in the SRS resource set, or in the SRS resource set with lower srs-ResourceSetId of two SRS resources sets, configured by higher layer parameter *srs-ResourceSetToAddModList*, if any, and associated with the higher layer parameter *usage* of value 'nonCodeBook', except for the higher layer parameters '*srs-ResourceSetId*' and '*srs-ResourceIdList*', and
  - if UE supports operation with *maxMIMO-LayersDCI-0-2* and the higher layer parameter *maxMIMO-LayersDCI-0-2* of *PUSCH-ServingCellConfig* of the serving cell is configured,  $L_{max}$  is given by that parameter
  - otherwise,  $L_{max}$  is given by the maximum number of layers for PUSCH supported by the UE for the serving cell for non-codebook based operation.
- $\left\lceil \log_2 N_{SRS,0,2} \right\rceil$  bits according to Tables 7.3.1.1.2-32/32A/32B if the higher layer parameter *txConfig* = *codebook*, where  $N_{SRS,0,2}$  is the number of configured SRS resources in the SRS resource set indicated by SRS resource set indicator field if present, otherwise  $N_{SRS,0,2}$  is the number of configured SRS resources in the SRS resource set configured by higher layer parameter *srs-ResourceSetToAddModListDCI-0-2* and associated with the higher layer parameter *usage* of value 'codeBook', where the SRS resource set is composed of the first  $N_{SRS,0,2}$  SRS resources together with other configurations in the SRS resource set configured by higher layer parameter *srs-ResourceSetToAddModList*, if any, and associated with the higher layer parameter *usage* of value 'codeBook', except for the higher layer parameters '*srs-ResourceSetId*' and '*srs-ResourceIdList*'.
- Second SRS resource indicator – 0,  $\left\lceil \log_2 \left( \max_{k \in \{1,2,\dots,\min\{L_{max}, N_{SRS,0,2}\}} \binom{N_{SRS,0,2}}{k} \right) \right\rceil$  or  $\left\lceil \log_2 N_{SRS,0,2} \right\rceil$  bits,
  - $\left\lceil \log_2 \left( \max_{k \in \{1,2,\dots,\min\{L_{max}, N_{SRS,0,2}\}} \binom{N_{SRS,0,2}}{k} \right) \right\rceil$  bits according to Tables 7.3.1.1.2-28/29A/30A/31A with the same number of layers indicated by SRS resource indicator field if the higher layer parameter *txConfig* = *nonCodebook* and SRS resource set indicator field is present, where  $N_{SRS,0,2}$  is the number of configured SRS resources in the second SRS resource set, and
    - if UE supports operation with *maxMIMO-LayersDCI-0-2* and the higher layer parameter *maxMIMO-LayersDCI-0-2* of *PUSCH-ServingCellConfig* of the serving cell is configured,  $L_{max}$  is given by that parameter
    - otherwise,  $L_{max}$  is given by the maximum number of layers for PUSCH supported by the UE for the serving cell for non-codebook based operation.
  - $\left\lceil \log_2 N_{SRS,0,2} \right\rceil$  bits according to Tables 7.3.1.1.2-32/32A/32B if the higher layer parameter *txConfig* = *codebook* and SRS resource set indicator field is present, where  $N_{SRS,0,2}$  is the number of configured SRS resources in the second SRS resource set.
  - 0 bit otherwise.
- Precoding information and number of layers – number of bits determined by the following:

- 0 bits if the higher layer parameter *txConfig* = *nonCodeBook*;
- 0 bits for 1 antenna port and if the higher layer parameter *txConfig* = *codebook*;
- 4, 5, or 6 bits according to Table 7.3.1.1.2-2 for 4 antenna ports by replacing *maxRank* and *codebookSubset* with *maxRankDCI-0-2* and *codebookSubsetDCI-0-2* respectively, if *txConfig* = *codebook*, *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower*, transform precoder is disabled, and according to the values of higher layer parameters *maxRankDCI-0-2*, and *codebookSubsetDCI-0-2*;
- 4 or 5 bits according to Table 7.3.1.1.2-2A for 4 antenna ports by replacing *maxRank* and *codebookSubset* with *maxRankDCI-0-2* and *codebookSubsetDCI-0-2* respectively, if *txConfig* = *codebook*, *ul-FullPowerTransmission* = *fullpowerMode1*, the values of higher layer parameters *maxRankDCI-0-2*=2, transform precoder is disabled, and according to the value of higher layer parameter *codebookSubsetDCI-0-2*;
- 4 or 6 bits according to Table 7.3.1.1.2-2B for 4 antenna ports by replacing *maxRank* and *codebookSubset* with *maxRankDCI-0-2* and *codebookSubsetDCI-0-2* respectively, if *txConfig* = *codebook*, *ul-FullPowerTransmission* = *fullpowerMode1*, the values of higher layer parameters *maxRankDCI-0-2*=3 or 4, transform precoder is disabled, and according to the value of higher layer parameter *codebookSubsetDCI-0-2*;
- 2, 4, or 5 bits according to Table 7.3.1.1.2-3 for 4 antenna ports by replacing *maxRank* and *codebookSubset* with *maxRankDCI-0-2* and *codebookSubsetDCI-0-2* respectively, if *txConfig* = *codebook*, *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower*, and according to whether transform precoder is enabled or disabled, and the values of higher layer parameters *maxRankDCI-0-2* and *codebookSubsetDCI-0-2*;
- 3 or 4 bits according to Table 7.3.1.1.2-3A for 4 antenna ports by replacing *maxRank* and *codebookSubset* with *maxRankDCI-0-2* and *codebookSubsetDCI-0-2* respectively, if *txConfig* = *codebook*, *ul-FullPowerTransmission* = *fullpowerMode1*, and according to whether transform precoder is enabled, or disabled and *maxRankDCI-0-2*=1, and the value of higher layer parameter *codebookSubsetDCI-0-2*;
- 2 or 4 bits according to Table 7.3.1.1.2-4 for 2 antenna ports by replacing *maxRank* and *codebookSubset* with *maxRankDCI-0-2* and *codebookSubsetDCI-0-2* respectively, if *txConfig* = *codebook*, *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower*, transform precoder is disabled, and according to the values of higher layer parameters *maxRankDCI-0-2* and *codebookSubsetDCI-0-2*;
- 2 bits according to Table 7.3.1.1.2-4A for 2 antenna ports by replacing *maxRank* and *codebookSubset* with *maxRankDCI-0-2* and *codebookSubsetDCI-0-2* respectively, if *txConfig* = *codebook*, *ul-FullPowerTransmission* = *fullpowerMode1*, transform precoder is disabled, the *maxRankDCI-0-2*=2, and *codebookSubsetDCI-0-2*=*nonCoherent*;
- 1 or 3 bits according to Table 7.3.1.1.2-5 for 2 antenna ports by replacing *maxRank* and *codebookSubset* with *maxRankDCI-0-2* and *codebookSubsetDCI-0-2* respectively, if *txConfig* = *codebook*, *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower*, and according to whether transform precoder is enabled or disabled, and the values of higher layer parameters *maxRankDCI-0-2* and *codebookSubsetDCI-0-2*;
- 2 bits according to Table 7.3.1.1.2-5A for 2 antenna ports by replacing *maxRank* and *codebookSubset* with *maxRankDCI-0-2* and *codebookSubsetDCI-0-2* respectively, if *txConfig* = *codebook*, *ul-FullPowerTransmission* = *fullpowerMode1*, and according to whether transform precoder is enabled, or disabled and *maxRankDCI-0-2*=1, and the value of higher layer parameter *codebookSubsetDCI-0-2*.

For the higher layer parameter *txConfig*=*codebook*, if *ul-FullPowerTransmission* is configured to *fullpowerMode2*, the values of higher layer parameters *maxRankDCI-0-2* is configured to be larger than 2, and at least one SRS resource with 4 antenna ports is configured in the SRS resource set indicated by SRS resource set indicator field if present, otherwise in an SRS resource set with usage set to 'codebook', and an SRS resource with 2 antenna ports is indicated via SRI in the same SRS resource set, then Table 7.3.1.1.2-4 is used by replacing *maxRank* and *codebookSubset* with *maxRankDCI-0-2* and *codebookSubsetDCI-0-2* respectively.

For the higher layer parameter *txConfig* = *codebook*, if different SRS resources with different number of antenna ports are configured, the bitwidth is determined according to the maximum number of ports in an SRS resource among the configured SRS resources in all SRS resource set(s) with usage set to 'codebook'. If the number of ports

for a configured SRS resource in the set is less than the maximum number of ports in an SRS resource among the configured SRS resources, a number of most significant bits with value set to '0' are inserted to the field.

- Second Precoding information – number of bits determined by the following:
  - 0 bits if SRS resource set indicator field is not present;
  - 0 bits if the higher layer parameter *txConfig* = *nonCodeBook*;
  - 0 bits for 1 antenna port and if the higher layer parameter *txConfig* = *codebook*;
  - 3, 4, or 5 bits according to Table 7.3.1.1.2-2C with the same number of layers indicated by Precoding information and number of layers field for 4 antenna ports by replacing *maxRank* and *codebookSubset* with *maxRankDCI-0-2* and *codebookSubsetDCI-0-2* respectively, if SRS resource set indicator field is present, *txConfig* = *codebook*, *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower*, transform precoder is disabled, and according to the values of higher layer parameters *maxRankDCI-0-2*, and *codebookSubsetDCI-0-2*;
  - 3 or 4 bits according to Table 7.3.1.1.2-2D with the same number of layers indicated by Precoding information and number of layers field for 4 antenna ports by replacing *maxRank* and *codebookSubset* with *maxRankDCI-0-2* and *codebookSubsetDCI-0-2* respectively, if SRS resource set indicator field is present, *txConfig* = *codebook*, *ul-FullPowerTransmission* = *fullpowerMode1*, the values of higher layer parameters *maxRankDCI-0-2*=2, transform precoder is disabled, and according to the value of higher layer parameter *codebookSubsetDCI-0-2*;
  - 3 or 4 bits according to Table 7.3.1.1.2-2E with the same number of layers indicated by Precoding information and number of layers field for 4 antenna ports by replacing *maxRank* and *codebookSubset* with *maxRankDCI-0-2* and *codebookSubsetDCI-0-2* respectively, if SRS resource set indicator field is present, *txConfig* = *codebook*, *ul-FullPowerTransmission* = *fullpowerMode1*, the values of higher layer parameters *maxRankDCI-0-2*=3 or 4, transform precoder is disabled, and according to the value of higher layer parameter *codebookSubsetDCI-0-2*;
  - 2, 4, or 5 bits according to Table 7.3.1.1.2-3 with the same number of layers indicated by Precoding information and number of layers field for 4 antenna ports by replacing *maxRank* and *codebookSubset* with *maxRankDCI-0-2* and *codebookSubsetDCI-0-2* respectively, if *txConfig* = *codebook*, *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower*, and according to whether transform precoder is enabled or disabled, and the values of higher layer parameters *maxRankDCI-0-2* and *codebookSubsetDCI-0-2*;
  - 3 or 4 bits according to Table 7.3.1.1.2-3A with the same number of layers indicated by Precoding information and number of layers field for 4 antenna ports by replacing *maxRank* and *codebookSubset* with *maxRankDCI-0-2* and *codebookSubsetDCI-0-2* respectively, if *txConfig* = *codebook*, *ul-FullPowerTransmission* = *fullpowerMode1*, *maxRankDCI-0-2*=1, and according to whether transform precoder is enabled or disabled, and the value of higher layer parameter *codebookSubsetDCI-0-2*;
  - 1 or 3 bits according to Table 7.3.1.1.2-4B with the same number of layers indicated by Precoding information and number of layers field for 2 antenna ports by replacing *maxRank* and *codebookSubset* with *maxRankDCI-0-2* and *codebookSubsetDCI-0-2* respectively, if SRS resource set indicator field is present, *txConfig* = *codebook*, *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower*, transform precoder is disabled, and according to the values of higher layer parameters *maxRankDCI-0-2* and *codebookSubsetDCI-0-2*;
  - 2 bits according to Table 7.3.1.1.2-4C with the same number of layers indicated by Precoding information and number of layers field for 2 antenna ports by replacing *maxRank* and *codebookSubset* with *maxRankDCI-0-2* and *codebookSubsetDCI-0-2* respectively, if SRS resource set indicator field is present, *txConfig* = *codebook*, *ul-FullPowerTransmission* = *fullpowerMode1*, transform precoder is disabled, the *maxRankDCI-0-2*=2, and *codebookSubsetDCI-0-2*=*nonCoherent*;
  - 1 or 3 bits according to Table 7.3.1.1.2-5 with the same number of layers indicated by Precoding information and number of layers field for 2 antenna ports by replacing *maxRank* and *codebookSubset* with *maxRankDCI-0-2* and *codebookSubsetDCI-0-2* respectively, if SRS resource set indicator field is present, *txConfig* = *codebook*, *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower*, and according to whether transform precoder is enabled or disabled, and the values of higher layer parameters *maxRankDCI-0-2* and *codebookSubsetDCI-0-2*;

- 2 bits according to Table 7.3.1.1.2-5A with the same number of layers indicated by Precoding information and number of layers field for 2 antenna ports by replacing *maxRank* and *codebookSubset* with *maxRankDCI-0-2* and *codebookSubsetDCI-0-2* respectively, if SRS resource set indicator field is present, *txConfig* = *codebook*, *ul-FullPowerTransmission* = *fullpowerMode1*, *maxRankDCI-0-2*=1, and according to whether transform precoder is enabled or disabled, and the value of higher layer parameter *codebookSubsetDCI-0-2*.

For the higher layer parameter *txConfig*=*codebook*, if *ul-FullPowerTransmission* is configured to *fullpowerMode2*, the values of higher layer parameters *maxRankDCI-0-2* is configured to be larger than 2, and at least one SRS resource with 4 antenna ports is configured in the SRS resource set indicated by SRS resource set indicator field, and an SRS resource with 2 antenna ports is indicated via Second SRS resource indicator field in the same SRS resource set, then Table 7.3.1.1.2-4B is used by replacing *maxRank* and *codebookSubset* with *maxRankDCI-0-2* and *codebookSubsetDCI-0-2* respectively.

For the higher layer parameter *txConfig* = *codebook*, if different SRS resources with different number of antenna ports are configured, the bitwidth is determined according to the maximum number of ports in an SRS resource among the configured SRS resources in the second SRS resource set with usage set to 'codebook' as defined in Table 7.3.1.1.2-36. If the number of ports for a configured SRS resource in the set is less than the maximum number of ports in an SRS resource among the configured SRS resources, a number of most significant bits with value set to '0' are inserted to the field.

- Antenna ports – number of bits determined by the following:
  - 0 bit if higher layer parameter *antennaPortsFieldPresenceDCI-0-2* is not configured;
  - 2, 3, 4, or 5 bits otherwise,
    - 2 bits as defined by Tables 7.3.1.1.2-6, if transform precoder is enabled, *dmrs-Type*=1, and *maxLength*=1, except that *dmrs-UplinkTransformPrecoding* and *tp-pi2BPSK* are both configured and  $\pi/2$  BPSK modulation is used;
    - 2 bits as defined by 7.3.1.1.2-6A, if transform precoder is enabled, and *dmrs-UplinkTransformPrecoding* and *tp-pi2BPSK* are both configured,  $\pi/2$  BPSK modulation is used, *dmrs-Type*=1, and *maxLength*=1, where  $n_{SCID}$  is the scrambling identity for antenna ports defined in Clause 6.4.1.1.1.2, in [4, TS38.211];
    - 4 bits as defined by Tables 7.3.1.1.2-7, if transform precoder is enabled, *dmrs-Type*=1, and *maxLength*=2, except that *dmrs-UplinkTransformPrecoding* and *tp-pi2BPSK* are both configured and  $\pi/2$  BPSK modulation is used;
    - 4 bits as defined by Tables 7.3.1.1.2-7A, if transform precoder is enabled, and *dmrs-UplinkTransformPrecoding* and *tp-pi2BPSK* are both configured,  $\pi/2$  BPSK modulation is used, *dmrs-Type*=1, and *maxLength*=2, where  $n_{SCID}$  is the scrambling identity for antenna ports defined in Clause 6.4.1.1.1.2, in [4, TS38.211];
    - 3 bits as defined by Tables 7.3.1.1.2-8/9/10/11, if transform precoder is disabled, *dmrs-Type*=1, and *maxLength*=1, and the value of rank is determined according to the SRS resource indicator field if the higher layer parameter *txConfig* = *nonCodebook* and according to the Precoding information and number of layers field if the higher layer parameter *txConfig* = *codebook*;
    - 4 bits as defined by Tables 7.3.1.1.2-12/13/14/15, if transform precoder is disabled, *dmrs-Type*=1, and *maxLength*=2, and the value of rank is determined according to the SRS resource indicator field if the higher layer parameter *txConfig* = *nonCodebook* and according to the Precoding information and number of layers field if the higher layer parameter *txConfig* = *codebook*;
    - 4 bits as defined by Tables 7.3.1.1.2-16/17/18/19, if transform precoder is disabled, *dmrs-Type*=2, and *maxLength*=1, and the value of rank is determined according to the SRS resource indicator field if the higher layer parameter *txConfig* = *nonCodebook* and according to the Precoding information and number of layers field if the higher layer parameter *txConfig* = *codebook*;
    - 5 bits as defined by Tables 7.3.1.1.2-20/21/22/23, if transform precoder is disabled, *dmrs-Type*=2, and *maxLength*=2, and the value of rank is determined according to the SRS resource indicator field if the higher layer parameter *txConfig* = *nonCodebook* and according to the Precoding information and number of layers field if the higher layer parameter *txConfig* = *codebook*.

where the number of CDM groups without data of values 1, 2, and 3 in Tables 7.3.1.1.2-6 to 7.3.1.1.2-23 refers to CDM groups {0}, {0,1}, and {0, 1,2} respectively.

If a UE is configured with both *dmrs-UplinkForPUSCH-MappingTypeA-DCI-0-2* and *dmrs-UplinkForPUSCH-MappingTypeB-DCI-0-2* and is configured with *antennaPortsFieldPresenceDCI-0-2*, the bitwidth of this field equals  $\max\{x_A, x_B\}$ , where  $x_A$  is the "Antenna ports" bitwidth derived according to *dmrs-UplinkForPUSCH-MappingTypeA-DCI-0-2* and  $x_B$  is the "Antenna ports" bitwidth derived according to *dmrs-UplinkForPUSCH-MappingTypeB-DCI-0-2*. A number of  $|x_A - x_B|$  zeros are padded in the MSB of this field, if the mapping type of the PUSCH corresponds to the smaller value of  $x_A$  and  $x_B$ .

If a UE is not configured with higher layer parameter *antennaPortsFieldPresenceDCI-0-2*, antenna port(s) are defined assuming bit field index value 0 in Tables 7.3.1.1.2-6 to 7.3.1.1.2-23.

- SRS request – 0, 1, 2 or 3 bits
  - 0 bit if the higher layer parameter *srs-RequestDCI-0-2* is not configured;
  - 1 bit as defined by Table 7.3.1.1.3-1 if higher layer parameter *srs-RequestDCI-0-2* = 1 and for UEs not configured with *supplementaryUplink* in *ServingCellConfig* in the cell;
  - 2 bits if higher layer parameter *srs-RequestDCI-0-2* = 1 and for UEs configured with *supplementaryUplink* in *ServingCellConfig* in the cell, where the first bit is the non-SUL/SUL indicator as defined in Table 7.3.1.1.1-1 and the second bit is defined by Table 7.3.1.1.3-1;
  - 2 bits as defined by Table 7.3.1.1.2-24 if higher layer parameter *srs-RequestDCI-0-2* = 2 and for UEs not configured with *supplementaryUplink* in *ServingCellConfig* in the cell;
  - 3 bits if higher layer parameter *srs-RequestDCI-0-2* = 2 and for UEs configured with *supplementaryUplink* in *ServingCellConfig* in the cell, where the first bit is the non-SUL/SUL indicator as defined in Table 7.3.1.1.1-1 and the second and third bits are defined by Table 7.3.1.1.2-24;
- SRS offset indicator – 0, 1 or 2 bits.
  - 0 bit if higher layer parameter *AvailableSlotOffset* is not configured for any aperiodic SRS resource set in the scheduled cell, or if higher layer parameter *AvailableSlotOffset* is configured for at least one aperiodic SRS resource set in the scheduled cell and the maximum number of entries of *availableSlotOffsetList* configured for all aperiodic SRS resource set(s) is 1;
  - otherwise,  $\lceil \log_2(K) \rceil$  bits are used to indicate available slot offset according to Table 7.3.1.1.2-37 and Clause 6.2.1 of [6, TS 38.214], where K is the maximum number of entries of *availableSlotOffsetList* configured for all aperiodic SRS resource set(s) in the scheduled cell;
- CSI request – 0, 1, 2, 3, 4, 5, or 6 bits determined by higher layer parameter *reportTriggerSizeDCI-0-2*.
- PTRS-DMRS association – number of bits determined as follows
  - 0 bit if *PTRS-UplinkConfig* is not configured in either *dmrs-UplinkForPUSCH-MappingTypeA* or *dmrs-UplinkForPUSCH-MappingTypeB* and transform precoder is disabled, or if transform precoder is enabled, or if *maxRankDCI-0-2*=1 or *maxMIMO-LayersDCI-0-2*=1;
  - 2 bits otherwise, where Table 7.3.1.1.2-25/7.3.1.1.2-25A and 7.3.1.1.2-26 are used to indicate the association between PTRS port(s) and DMRS port(s) when one PT-RS port and two PT-RS ports are configured by *maxNrofPorts* in *PTRS-UplinkConfig* respectively, and the DMRS ports are indicated by the Antenna ports field. When the SRS resource set indicator field is present and *maxRankDCI-0-2*>2 or *maxMIMO-LayersDCI-0-2*>2, this field indicates the association between PTRS port(s) and DMRS port(s) corresponding to SRS resource indicator field and/or Precoding information and number of layers field according to Table 7.3.1.1.2-25 and 7.3.1.1.2-26 field according to Table 7.3.1.1.2-25 and 7.3.1.1.2-26. When the SRS resource set indicator field is present and equals "10" or "11" and *maxRankDCI-0-2*=2 or *maxMIMO-LayersDCI-0-2*=2, the MSB of this field indicates the association between PTRS port(s) and DMRS port(s) corresponding to SRS resource indicator field and/or Precoding information and number of layers field, and the LSB of this field indicates the association between PTRS port(s) and DMRS port(s) corresponding to Second SRS resource indicator field and/or Second Precoding information field, according to Table 7.3.1.1.2-25A.

If "Bandwidth part indicator" field indicates a bandwidth part other than the active bandwidth part and the "PTRS-DMRS association" field is present for the indicated bandwidth part but not present for the active bandwidth part, the UE assumes the "PTRS-DMRS association" field is not present for the indicated bandwidth part.

- Second PTRS-DMRS association – 2 bits if PTRS-DMRS association field and SRS resource set indicator field are present and  $\maxRankDCI-0-2 > 2$  or  $\maxMIMO-LayersDCI-0-2 > 2$ ; 0 bit otherwise. Table 7.3.1.1.2-25 and 7.3.1.1.2-26 are used to indicate the association between PTRS port(s) and DMRS port(s) corresponding to Second SRS resource indicator field and/or Second precoding information field when one PT-RS port and two PT-RS ports are configured by  $\maxNrofPorts$  in *PTRS-UplinkConfig* respectively, and the DMRS ports are indicated by the Antenna ports field.
- beta\_offset indicator – 0 bit if the higher layer parameter  $\beta_{offsetsDCI-0-2} = semiStaticDCI-0-2$ ; otherwise 1 bit if 2 offset indexes are configured by higher layer parameter  $dynamicDCI-0-2$  as defined by Table 9.3-3A in [5, TS 38.213], and 2 bits if 4 offset indexes are configured by higher layer parameter  $dynamicDCI-0-2$  as defined by Table 9.3-3 in [5, TS 38.213].

When two HARQ-ACK codebooks are configured by *pdsch-HARQ-ACK-CodebookList* or by *pdsch-HARQ-ACK-CodebookListMulticast* for the same serving cell and if higher layer parameter  $priorityIndicatorDCI-0-2$  is configured, if the bit width of the beta\_offset indicator in DCI format 0\_2 for one HARQ-ACK codebook is not equal to that of the beta\_offset indicator in DCI format 0\_2 for the other HARQ-ACK codebook, a number of most significant bits with value set to '0' are inserted to smaller beta\_offset indicator until the bit width of the beta\_offset indicator in DCI format 0\_2 for the two HARQ-ACK codebooks are the same.

- DMRS sequence initialization – 0 or 1 bit
  - 0 bit if the higher layer parameter  $dmrs-SequenceInitializationDCI-0-2$  is not configured or if transform precoder is enabled;
  - 1 bit if transform precoder is disabled and the higher layer parameter  $dmrs-SequenceInitializationDCI-0-2$  is configured.
- UL-SCH indicator – 1 bit. A value of "1" indicates UL-SCH shall be transmitted on the PUSCH and a value of "0" indicates UL-SCH shall not be transmitted on the PUSCH. If a UE does not support triggering SRS only in DCI, except for DCI format 0\_2 with CRC scrambled by SP-CSI-RNTI, the UE is not expected to receive a DCI format 0\_2 with UL-SCH indicator of "0" and CSI request of all zero(s). If a UE supports triggering SRS only in DCI, except for DCI format 0\_2 with CRC scrambled by SP-CSI-RNTI, the UE is not expected to receive a DCI format 0\_2 with UL-SCH indicator of "0", CSI request of all zero(s) and SRS request of all zero(s).
- ChannelAccess-CPext-CAPC – 0, 1, 2, 3, 4, 5 or 6 bits. The bitwidth for this field is determined as  $\lceil \log_2(I) \rceil$  bits, where  $I$  is the number of entries in the higher layer parameter  $ul-AccessConfigListDCI-0-2$  or in Table 7.3.1.1.1-4A if  $channelAccessMode-r16 = "semiStatic"$  is provided, for operation in a cell with shared spectrum channel access in frequency range 1, or the number of entries in the high layer parameter  $ul-AccessConfigListDCI-0-1$  for operation in frequency range 2-2 if  $ChannelAccessMode2-r17$  is provided; otherwise 0 bit. One or more entries from Table 7.3.1.1.2-35 are configured by the higher layer parameter  $ul-AccessConfigListDCI-0-2$  in frequency range 1. One or more entries from Table 7.3.1.1.2-35A are configured by the higher layer parameter  $ul-AccessConfigListDCI-0-1$  in frequency range 2-2.
- Open-loop power control parameter set indication – 0 or 1 or 2 bits.
  - 0 bit if the higher layer parameter  $p0-PUSCH-SetList$  is not configured;
  - 1 or 2 bits otherwise,
    - 1 bit if SRS resource indicator is present in the DCI format 0\_2;
    - 1 or 2 bits as determined by higher layer parameter  $olpc-ParameterSetDCI-0-2$  if SRS resource indicator is not present in the DCI format 0\_2;
- Priority indicator – 0 bit if higher layer parameter  $priorityIndicatorDCI-0-2$  is not configured; otherwise 1 bit as defined in Clause 9 in [5, TS 38.213].
- Invalid symbol pattern indicator – 0 bit if higher layer parameter  $invalidSymbolPatternIndicatorDCI-0-2$  is not configured; otherwise 1 bit as defined in Clause 6.1.2.1 in [6, TS 38.214].

- PDCCH monitoring adaptation indication – 0, 1 or 2 bits
- 1 or 2 bits, if *searchSpaceGroupIdList-r17* is not configured and if *pdccch-SkippingDurationList* is configured
  - 1 bit if the UE is configured with only one duration by *pdccch-SkippingDurationList*;
  - 2 bits if the UE is configured with more than one duration by *pdccch-SkippingDurationList*.
- 1 or 2 bits, if *pdccch-SkippingDurationList* is not configured and if *searchSpaceGroupIdList-r17* is configured
  - 1 bit if the UE is configured by *searchSpaceGroupIdList-r17* with search space set(s) with group index 0 and search space set(s) with group index 1, and if the UE is not configured by *searchSpaceGroupIdList-r17* with any search space set with group index 2;
  - 2 bits if the UE is configured by *searchSpaceGroupIdList-r17* with search space set(s) with group index 0, search space set(s) with group index 1 and search space set(s) with group index 2;
- 2 bits, if *pdccch-SkippingDurationList* is configured and if *searchSpaceGroupIdList-r17* is configured
- 0 bit, otherwise

A UE does not expect that the bit width of a field in DCI format 0\_2 with CRC scrambled by CS-RNTI is larger than corresponding bit width of same field in DCI format 0\_2 with CRC scrambled by C-RNTI for the same serving cell. If the bit width of a field in the DCI format 0\_2 with CRC scrambled by CS-RNTI is not equal to that of the corresponding field in the DCI format 0\_2 with CRC scrambled by C-RNTI for the same serving cell, a number of most significant bits with value set to '0' are inserted to the field in DCI format 0\_2 with CRC scrambled by CS-RNTI until the bit width equals that of the corresponding field in the DCI format 0\_2 with CRC scrambled by C-RNTI for the same serving cell.

For a UE configured with scheduling on the primary cell from an SCell, if prior to padding the number of information bits in DCI format 0\_2 carried by PDCCH on the primary cell is not equal to the number of information bits in DCI format 0\_2 carried by PDCCH on the SCell for scheduling on the primary cell, zeros shall be appended to the DCI format 0\_2 with smaller size until the payload size is the same.

- If application of step 4B in clause 7.3.1.0 results in additional zero padding for DCI format 0\_2 for scheduling on the primary cell, corresponding zeros shall be appended to both DCI format 0\_2 monitored on the primary cell and DCI format 0\_2 monitored on the SCell for scheduling on the primary cell.
- If the SCell is deactivated and *firstActiveDownlinkBWP-Id* is not set to dormant BWP, the UE determines the number of information bits in DCI format 0\_2 carried by PDCCH on the primary cell based on a DL BWP provided by *firstActiveDownlinkBWP-Id* for the SCell. If the active DL BWP of the SCell is a dormant DL BWP, or if the SCell is deactivated and *firstActiveDownlinkBWP-Id* is set to dormant BWP, the UE determines the number of information bits in DCI format 0\_2 carried by PDCCH on the primary cell based on a DL BWP provided by *firstWithinActiveTimeBWP-Id* for the SCell if provided; otherwise, based on a DL BWP provided by *firstOutsideActiveTimeBWP-Id* for the SCell.

**Table 7.3.1.1.3-1: 1 bit SRS request in DCI format 0\_2 and DCI format 1\_2**

| Value of SRS request field | Triggered aperiodic SRS resource set(s) for DCI format 0_2 and 1_2                                                                                                      |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0                          | No aperiodic SRS resource set triggered                                                                                                                                 |
| 1                          | SRS resource set(s) configured with higher layer parameter <i>aperiodicSRS-ResourceTrigger</i> set to 1 or an entry in <i>aperiodicSRS-ResourceTriggerList</i> set to 1 |



### 7.3.1.2 DCI formats for scheduling of PDSCH

#### 7.3.1.2.1 Format 1\_0

DCI format 1\_0 is used for the scheduling of PDSCH in one DL cell.

The following information is transmitted by means of the DCI format 1\_0 with CRC scrambled by C-RNTI or CS-RNTI or MCS-C-RNTI:

- Identifier for DCI formats – 1 bits
  - The value of this bit field is always set to 1, indicating a DL DCI format
- Frequency domain resource assignment –  $\left\lceil \log_2(N_{RB}^{DL,BWP}(N_{RB}^{DL,BWP} + 1)/2) \right\rceil$  bits where  $N_{RB}^{DL,BWP}$  is given by clause 7.3.1.0

If the CRC of the DCI format 1\_0 is scrambled by C-RNTI and the "Frequency domain resource assignment" field are of all ones, the DCI format 1\_0 is for random access procedure initiated by a PDCCH order, with all remaining fields set as follows:

- Random Access Preamble index – 6 bits according to *ra-PreambleIndex* in Clause 5.1.2 of [8, TS38.321]
- UL/SUL indicator – 1 bit. If the value of the "Random Access Preamble index" is not all zeros and if the UE is configured with *supplementaryUplink* in *ServingCellConfig* in the cell, this field indicates which UL carrier in the cell to transmit the PRACH according to Table 7.3.1.1.1-1; otherwise, this field is reserved
- SS/PBCH index – 6 bits. If the value of the "Random Access Preamble index" is not all zeros, this field indicates the SS/PBCH that shall be used to determine the RACH occasion for the PRACH transmission; otherwise, this field is reserved.
- PRACH Mask index – 4 bits. If the value of the "Random Access Preamble index" is not all zeros, this field indicates the RACH occasion associated with the SS/PBCH indicated by "SS/PBCH index" for the PRACH transmission, according to Clause 5.1.1 of [8, TS38.321]; otherwise, this field is reserved
- Reserved bits – 12 bits for operation in a cell with shared spectrum channel access in frequency range 1 or when the DCI format is monitored in common search space for operation in a cell in frequency range 2-2; otherwise 10 bits

Otherwise, all remaining fields are set as follows:

- Time domain resource assignment – 4 bits as defined in Clause 5.1.2.1 of [6, TS 38.214]
- VRB-to-PRB mapping – 1 bit according to Table 7.3.1.2.2-5
- Modulation and coding scheme – 5 bits as defined in Clause 5.1.3 of [6, TS 38.214]
- New data indicator – 1 bit
- Redundancy version – 2 bits as defined in Table 7.3.1.1.1-2
- HARQ process number – 4 bits
- Downlink assignment index – 2 bits as defined in Clause 9.1.3 of [5, TS 38.213], as counter DAI
- TPC command for scheduled PUCCH – 2 bits as defined in Clause 7.2.1 of [5, TS 38.213]
- PUCCH resource indicator – 3 bits as defined in Clause 9.2.3 of [5, TS 38.213]
- PDSCH-to-HARQ\_feedback timing indicator – 3 bits as defined in Clause 9.2.3 of [5, TS38.213]
- ChannelAccess-CPext – 2 bits indicating combinations of channel access type and CP extension as defined in Table 7.3.1.1.1-4, or Table 7.3.1.1.1-4A if *channelAccessMode-r16* = "semiStatic" is provided, for operation in a cell with shared spectrum channel access in frequency range 1; 2 bits indicating channel access type as defined in Table 7.3.1.1.1-4B if *ChannelAccessMode2-r17* is provided for operation in a cell in frequency range 2-2; 0 bits otherwise

- Reserved bits – 2 bits when the DCI format is monitored in common search space for operation in a cell in frequency range 2-2 and the number of bits for the field of 'ChannelAccess-CPext' is 0; 0 bits otherwise

The following information is transmitted by means of the DCI format 1\_0 with CRC scrambled by P-RNTI:

- Short Messages Indicator – 2 bits according to Table 7.3.1.2.1-1.
- Short Messages – 8 bits, according to Clause 6.5 of [9, TS38.331]. If only the scheduling information for Paging, and TRS availability indication if *trs-ResourceSetConfig* is configured, are carried, this bit field is reserved.
- Frequency domain resource assignment –  $\left\lceil \log_2(N_{RB}^{DL,BWP}(N_{RB}^{DL,BWP} + 1)/2) \right\rceil$  bits. If only the short message, and TRS availability indication if *trs-ResourceSetConfig* is configured, are carried, this bit field is reserved.
- $N_{RB}^{DL,BWP}$  is the size of CORESET 0
- Time domain resource assignment – 4 bits as defined in Clause 5.1.2.1 of [6, TS38.214]. If only the short message, and TRS availability indication if *trs-ResourceSetConfig* is configured, are carried, this bit field is reserved.
- VRB-to-PRB mapping – 1 bit according to Table 7.3.1.2.2-5. If only the short message, and TRS availability indication if *trs-ResourceSetConfig* is configured, are carried, this bit field is reserved.
- Modulation and coding scheme – 5 bits as defined in Clause 5.1.3 of [6, TS38.214], using Table 5.1.3.1-1. If only the short message, and TRS availability indication if *trs-ResourceSetConfig* is configured, are carried, this bit field is reserved.
- TB scaling – 2 bits as defined in Clause 5.1.3.2 of [6, TS38.214]. If only the short message, and TRS availability indication if *trs-ResourceSetConfig* is configured, are carried, this bit field is reserved.
- TRS availability indication – 1, 2, 3, 4, 5, or 6 bits, where the number of bits is equal to one plus the highest value of all the *indBitID*(s) provided by the *trs-ResourceSetConfig* if configured; 0 bits otherwise.
- Reserved bits –  $(8 - M)$  bits for operation in a cell with shared spectrum channel access in frequency range 1 or for operation in a cell in frequency range 2-2;  $(6 - M)$  bits for operation in a cell without shared spectrum channel access, where the value of  $M$  is the number of bits for the field of 'TRS availability indication' as defined above.

The following information is transmitted by means of the DCI format 1\_0 with CRC scrambled by SI-RNTI:

- Frequency domain resource assignment –  $\left\lceil \log_2(N_{RB}^{DL,BWP}(N_{RB}^{DL,BWP} + 1)/2) \right\rceil$  bits
- $N_{RB}^{DL,BWP}$  is the size of CORESET 0
- Time domain resource assignment – 4 bits as defined in Clause 5.1.2.1 of [6, TS38.214]
- VRB-to-PRB mapping – 1 bit according to Table 7.3.1.2.2-5
- Modulation and coding scheme – 5 bits as defined in Clause 5.1.3 of [6, TS38.214], using Table 5.1.3.1-1
- Redundancy version – 2 bits as defined in Table 7.3.1.1.1-2
- System information indicator – 1 bit as defined in Table 7.3.1.2.1-2
- Reserved bits – 17 bits for operation in a cell with shared spectrum channel access in frequency range 1 or for operation in a cell in frequency range 2-2; otherwise 15 bits

The following information is transmitted by means of the DCI format 1\_0 with CRC scrambled by RA-RNTI or MsgB-RNTI:

- Frequency domain resource assignment –  $\left\lceil \log_2(N_{RB}^{DL,BWP}(N_{RB}^{DL,BWP} + 1)/2) \right\rceil$  bits
  - $N_{RB}^{DL,BWP}$  is the size of CORESET 0 if CORESET 0 is configured for the cell and  $N_{RB}^{DL,BWP}$  is the size of initial DL bandwidth part if CORESET 0 is not configured for the cell
- Time domain resource assignment – 4 bits as defined in Clause 5.1.2.1 of [6, TS38.214]
- VRB-to-PRB mapping – 1 bit according to Table 7.3.1.2.2-5
- Modulation and coding scheme – 5 bits as defined in Clause 5.1.3 of [6, TS38.214], using Table 5.1.3.1-1
- TB scaling – 2 bits as defined in Clause 5.1.3.2 of [6, TS38.214]
- LSBs of SFN – 2 bits for the DCI format 1\_0 with CRC scrambled by MsgB-RNTI as defined in Clause 8.2A of [5, TS 38.213] if *msgB-responseWindow* is configured to be larger than 10 ms; or 2 bits for the DCI format 1\_0 with CRC scrambled by RA-RNTI as defined in Clause 8.2 of [5, TS 38.213] for operation in a cell with shared spectrum channel access if *ra-ResponseWindow* or *ra-ResponseWindow-v1610* is configured to be larger than 10 ms; 0 bit otherwise
- Reserved bits – (16 – A) bits for operation in a cell without shared spectrum access in frequency range 1 and frequency range 2-1, (18 – A) for operation in a cell with shared spectrum access in frequency range 1 or for operation in a cell in frequency range 2-2, where the value of A is the number of bits for the field of 'LSBs of SFN' as defined above

The following information is transmitted by means of the DCI format 1\_0 with CRC scrambled by TC-RNTI:

- Identifier for DCI formats – 1 bit
  - The value of this bit field is always set to 1, indicating a DL DCI format
- Frequency domain resource assignment –  $\left\lceil \log_2(N_{RB}^{DL,BWP}(N_{RB}^{DL,BWP} + 1)/2) \right\rceil$  bits
  - $N_{RB}^{DL,BWP}$  is the size of CORESET 0
- Time domain resource assignment – 4 bits as defined in Clause 5.1.2.1 of [6, TS38.214]
- VRB-to-PRB mapping – 1 bit according to Table 7.3.1.2.2-5
- Modulation and coding scheme – 5 bits as defined in Clause 5.1.3 of [6, TS38.214], using Table 5.1.3.1-1
- New data indicator – 1 bit
- Redundancy version – 2 bits as defined in Table 7.3.1.1.1-2
- HARQ process number – 4 bits
- Downlink assignment index – 2 bits, reserved
- TPC command for scheduled PUCCH – 2 bits as defined in Clause 7.2.1 of [5, TS38.213]
- PUCCH resource indicator – 3 bits as defined in Clause 9.2.3 of [5, TS38.213]
- PDSCH-to-HARQ\_feedback timing indicator – 3 bits as defined in Clause 9.2.3 of [5, TS38.213]
- ChannelAccess-CPext – 2 bits indicating combinations of channel access type and CP extension as defined in Table 7.3.1.1.1-4, or Table 7.3.1.1.1-4A if *channelAccessMode-r16* = "semiStatic" is provided, for operation in a cell with shared spectrum channel access in frequency range 1; 2 bits indicating channel access type as defined in Table 7.3.1.1.1-4B if *ChannelAccessMode2-r17* is provided for operation in a cell in frequency range 2-2; otherwise 0 bit
- Reserved bits – 2 bits when the DCI format is monitored in common search space for operation in a cell in frequency range 2-2 and the number of bits for the field of 'ChannelAccess-CPext' is 0; 0 bits otherwise

**Table 7.3.1.2.1-1: Short Message indicator**

| Bit field | Short Message indicator                                                                                                                               |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| 00        | Reserved                                                                                                                                              |
| 01        | Only scheduling information for Paging, and TRS availability indication if <i>trs-ResourceSetConfig</i> is configured, are present in the DCI         |
| 10        | Only short message, and TRS availability indication if <i>trs-ResourceSetConfig</i> is configured, are present in the DCI                             |
| 11        | Scheduling information for Paging, TRS availability indication if <i>trs-ResourceSetConfig</i> is configured and short message are present in the DCI |

**Table 7.3.1.2.1-2: System information indicator**

| Bit field | System information indicator           |
|-----------|----------------------------------------|
| 0         | SIB1 [9, TS38.331, Clause 5.2.1]       |
| 1         | SI message [9, TS38.331, Clause 5.2.1] |

### 7.3.1.2.2 Format 1\_1

DCI format 1\_1 is used for the scheduling of one or multiple PDSCH in one cell.

The following information is transmitted by means of the DCI format 1\_1 with CRC scrambled by C-RNTI or CS-RNTI or MCS-C-RNTI:

- Identifier for DCI formats – 1 bits
  - The value of this bit field is always set to 1, indicating a DL DCI format
- Carrier indicator – 0 or 3 bits as defined in Clause 10.1 of [5, TS 38.213]. This field is reserved when this format is carried by PDCCH on the primary cell and the UE is configured for scheduling on the primary cell from an SCell, with the same number of bits as that in this format carried by PDCCH on the SCell for scheduling on the primary cell.
- Bandwidth part indicator – 0, 1 or 2 bits as determined by the number of DL BWPs  $n_{\text{BWP,RRC}}$  configured by higher layers, excluding the initial DL bandwidth part. The bitwidth for this field is determined as  $\lceil \log_2(n_{\text{BWP}}) \rceil$  bits, where
  - $n_{\text{BWP}} = n_{\text{BWP,RRC}} + 1$  if  $n_{\text{BWP,RRC}} \leq 3$ , in which case the bandwidth part indicator is equivalent to the ascending order of the higher layer parameter *BWP-Id*;
  - otherwise  $n_{\text{BWP}} = n_{\text{BWP,RRC}}$ , in which case the bandwidth part indicator is defined in Table 7.3.1.1.2-1;

If a UE does not support active BWP change via DCI, the UE ignores this bit field.

- Frequency domain resource assignment – number of bits determined by the following, where  $N_{\text{RB}}^{\text{DL,BWP}}$  is the size of the active DL bandwidth part:
  - $N_{\text{RBG}}$  bits if only resource allocation type 0 is configured, where  $N_{\text{RBG}}$  is defined in Clause 5.1.2.2.1 of [6, TS38.214],
  - $\lceil \log_2(N_{\text{RB}}^{\text{DL,BWP}}(N_{\text{RB}}^{\text{DL,BWP}} + 1)/2) \rceil$  bits if only resource allocation type 1 is configured, or
  - $\max\left(\lceil \log_2(N_{\text{RB}}^{\text{DL,BWP}}(N_{\text{RB}}^{\text{DL,BWP}} + 1)/2) \rceil, N_{\text{RBG}}\right) + 1$  bits if *resourceAllocation* is configured as 'dynamicSwitch'.
  - If *resourceAllocation* is configured as 'dynamicSwitch', the MSB bit is used to indicate resource allocation type 0 or resource allocation type 1, where the bit value of 0 indicates resource allocation type 0 and the bit value of 1 indicates resource allocation type 1.

- For resource allocation type 0, the  $N_{\text{RBG}}$  LSBs provide the resource allocation as defined in Clause 5.1.2.2.1 of [6, TS 38.214].
- For resource allocation type 1, the  $\lceil \log_2(N_{\text{RB}}^{\text{DL,BWP}}(N_{\text{RB}}^{\text{DL,BWP}} + 1)/2) \rceil$  LSBs provide the resource allocation as defined in Clause 5.1.2.2.2 of [6, TS 38.214]

If "Bandwidth part indicator" field indicates a bandwidth part other than the active bandwidth part and if *resourceAllocation* is configured as 'dynamicSwitch' for the indicated bandwidth part, the UE assumes resource allocation type 0 for the indicated bandwidth part if the bitwidth of the "Frequency domain resource assignment" field of the active bandwidth part is smaller than the bitwidth of the "Frequency domain resource assignment" field of the indicated bandwidth part.

- Time domain resource assignment – 0, 1, 2, 3, 4, 5 or 6 bits
  - If the higher layer parameter *pdsch-TimeDomainAllocationListForMultiPDSCH* is not configured and if the higher layer parameter *pdsch-TimeDomainAllocationList* is configured, 0, 1, 2, 3 or 4 bits as defined in Clause 5.1.2.1 of [6, TS 38.214]. The bitwidth for this field is determined as  $\lceil \log_2(I) \rceil$  bits, where  $I$  is the number of entries in the higher layer parameter *pdsch-TimeDomainAllocationList* if the higher layer parameter is configured;
  - if the higher layer parameter *pdsch-TimeDomainAllocationListForMultiPDSCH* is configured, 0, 1, 2, 3, 4, 5 or 6 bits as defined in Clause 5.1.2.1 of [6, TS38.214]. The bitwidth for this field is determined as  $\lceil \log_2(I) \rceil$  bits, where  $I$  is the number of entries in the higher layer parameter *pdsch-TimeDomainAllocationListForMultiPDSCH*;
  - otherwise  $I$  is the number of entries in the default table.
- VRB-to-PRB mapping – 0 or 1 bit:
  - 0 bit if only resource allocation type 0 is configured or if interleaved VRB-to-PRB mapping is not configured by high layers;
  - 1 bit according to Table 7.3.1.2.2-5 otherwise, only applicable to resource allocation type 1, as defined in Clause 7.3.1.6 of [4, TS 38.211].
- PRB bundling size indicator – 0 bit if the higher layer parameter *prb-BundlingType* is not configured or is set to 'staticBundling', or 1 bit if the higher layer parameter *prb-BundlingType* is set to 'dynamicBundling' according to Clause 5.1.2.3 of [6, TS 38.214].
- Rate matching indicator – 0, 1, or 2 bits according to higher layer parameters *rateMatchPatternGroup1* and *rateMatchPatternGroup2*, where the MSB is used to indicate *rateMatchPatternGroup1* and the LSB is used to indicate *rateMatchPatternGroup2* when there are two groups.
- ZP CSI-RS trigger – 0, 1, or 2 bits as defined in Clause 5.1.4.2 of [6, TS 38.214]. The bitwidth for this field is determined as  $\lceil \log_2(n_{\text{ZP}} + 1) \rceil$  bits, where  $n_{\text{ZP}}$  is the number of aperiodic ZP CSI-RS resource sets configured by higher layer.

For transport block 1:

- Modulation and coding scheme – 5 bits as defined in Clause 5.1.3.1 of [6, TS 38.214]
- New data indicator – 1 bit if the number of scheduled PDSCH indicated by the Time domain resource assignment field is 1; otherwise 2, 3, 4, 5, 6, 7 or 8 bits determined based on the maximum number of schedulable PDSCH among all entries in the higher layer parameter *pdsch-TimeDomainAllocationListForMultiPDSCH*, where each bit corresponds to one scheduled PDSCH as defined in clause 5.1.3 in [6, TS 38.214].
- Redundancy version – number of bits determined by the following:
  - 2 bits as defined in Table 7.3.1.1.1-2 if the number of scheduled PDSCH indicated by the Time domain resource assignment field is 1;
  - otherwise 2, 3, 4, 5, 6, 7 or 8 bits determined by the maximum number of schedulable PDSCHs among all entries in the higher layer parameter *pdsch-TimeDomainAllocationListForMultiPDSCH*, where each bit

corresponds to one scheduled PDSCH as defined in clause 5.1.3 in [6, TS 38.214] and redundancy version is determined according to Table 7.3.1.1.2-34.

For transport block 2 (only present if *maxNrofCodeWordsScheduledByDCI* equals 2):

- Modulation and coding scheme – 5 bits as defined in Clause 5.1.3.1 of [6, TS 38.214]
- New data indicator – 1 bit if the number of scheduled PDSCH indicated by the Time domain resource assignment field is 1; otherwise 2, 3, 4, 5, 6, 7 or 8 bits determined based on the maximum number of schedulable PDSCH among all entries in the higher layer parameter *pdsch-TimeDomainAllocationListForMultiPDSCH*, where each bit corresponds to one scheduled PDSCH as defined in clause 5.1.3 in [6, TS 38.214].
- Redundancy version – number of bits determined by the following:
  - 2 bits as defined in Table 7.3.1.1.1-2 if the number of scheduled PDSCH indicated by the Time domain resource assignment field is 1;
  - otherwise 2, 3, 4, 5, 6, 7 or 8 bits determined by the maximum number of schedulable PDSCHs among all entries in the higher layer parameter *pdsch-TimeDomainAllocationListForMultiPDSCH*, where each bit corresponds to one scheduled PDSCH as defined in clause 5.1.3 in [6, TS 38.214] and redundancy version is determined according to Table 7.3.1.1.2-34.

If "Bandwidth part indicator" field indicates a bandwidth part other than the active bandwidth part and the value of *maxNrofCodeWordsScheduledByDCI* for the indicated bandwidth part equals 2 and the value of *maxNrofCodeWordsScheduledByDCI* for the active bandwidth part equals 1, the UE assumes zeros are padded when interpreting the "Modulation and coding scheme", "New data indicator", and "Redundancy version" fields of transport block 2 according to Clause 12 of [5, TS38.213], and the UE ignores the "Modulation and coding scheme", "New data indicator", and "Redundancy version" fields of transport block 2 for the indicated bandwidth part.

- HARQ process number – 5 bits if higher layer parameter *harq-ProcessNumberSizeDCI-1-1* is configured; otherwise 4 bits
- Downlink assignment index – number of bits as defined in the following
  - 6 bits if more than one serving cell are configured in the DL and the higher layer parameter *nfi-TotalDAI-Included* is configured. The 4 MSB bits are the counter DAI and the total DAI for the scheduled PDSCH group, and the 2 LSB bits are the total DAI for the non-scheduled PDSCH group.
  - 4 bits if only one serving cell is configured in the DL and the higher layer parameter *nfi-TotalDAI-Included* is configured. The 2 MSB bits are the counter DAI for the scheduled PDSCH group, and the 2 LSB bits are the total DAI for the non-scheduled PDSCH group;
  - 4 bits if more than one serving cell are configured in the DL, the higher layer parameter *pdsch-HARQ-ACK-Codebook=dynamic* or *pdsch-HARQ-ACK-Codebook-r16=enhancedDynamic*, and *nfi-TotalDAI-Included* is not configured, where the 2 MSB bits are the counter DAI and the 2 LSB bits are the total DAI;
  - 4 bits if one serving cell is configured in the DL, and the higher layer parameter *pdsch-HARQ-ACK-Codebook=dynamic*, and the UE is not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with value 0 for one or more first CORESETs and is provided *coresetPoolIndex* with value 1 for one or more second CORESETs, and is provided *ackNackFeedbackMode = joint*, where the 2 MSB bits are the counter DAI and the 2 LSB bits are the total DAI;
  - 2 bits if only one serving cell is configured in the DL, the higher layer parameter *pdsch-HARQ-ACK-Codebook=dynamic* or *pdsch-HARQ-ACK-Codebook-r16=enhancedDynamic*, and *nfi-TotalDAI-Included* is not configured, when the UE is not configured with *coresetPoolIndex* or the value of *coresetPoolIndex* is the same for all CORESETs if *coresetPoolIndex* is provided or the UE is not configured with *ackNackFeedbackMode = joint*, where the 2 bits are the counter DAI;
  - 0 bits otherwise.

If the UE is configured with a PUCCH-SCell, the number of serving cells is determined within a PUCCH group.

If the UE is configured with a PUCCH-SCell, *pdsch-HARQ-ACK-Codebook* is replaced by *pdsch-HARQ-ACK-Codebook-secondaryPUCCHgroup-r16* if present for the secondary PUCCH group.

If higher layer parameter *priorityIndicatorDCI-1-1* is configured, if the bit width of the Downlink assignment index in DCI format 1\_1 for one HARQ-ACK codebook is not equal to that of the Downlink assignment index in DCI format 1\_1 for the other HARQ-ACK codebook, a number of most significant bits with value set to '0' are inserted to smaller Downlink assignment index until the bit width of the Downlink assignment index in DCI format 1\_1 for the two HARQ-ACK codebooks are the same.

- TPC command for scheduled PUCCH – 2 bits as defined in Clause 7.2.1 of [5, TS 38.213]
- Second TPC command for scheduled PUCCH – 2 bits as defined in Clause 7.2.1 of [5, TS 38.213] if higher layer parameter *SecondTPCFieldDCI-1-1* is configured; 0 bit otherwise.
- PUCCH resource indicator – 3 bits as defined in Clause 9.2.3 of [5, TS 38.213]
- PDSCH-to-HARQ\_feedback timing indicator – 0, 1, 2, or 3 bits as defined in Clause 9.2.3 of [5, TS 38.213]. The bitwidth for this field is determined as  $\lceil \log_2(I) \rceil$  bits, where  $I$  is the number of entries in the higher layer parameter *dl-DataToUL-ACK*.

If higher layer parameter *priorityIndicatorDCI-1-1* is configured, if the bit width of the PDSCH-to-HARQ\_feedback timing indicator in DCI format 1\_1 for one HARQ-ACK codebook is not equal to that of the PDSCH-to-HARQ\_feedback timing indicator in DCI format 1\_1 for the other HARQ-ACK codebook on the same cell for PUCCH transmission, a number of most significant bits with value set to '0' are inserted to smaller PDSCH-to-HARQ\_feedback timing indicator until the bit width of the PDSCH-to-HARQ\_feedback timing indicator in DCI format 1\_1 for the two HARQ-ACK codebooks are the same.

If higher layer parameter *pucch-sCellDyn* is configured, if the bit width of the PDSCH-to-HARQ\_feedback timing indicator in DCI format 1\_1 associated with one cell for PUCCH transmission is not equal to that of the PDSCH-to-HARQ\_feedback timing indicator in DCI format 1\_1 associated with the other cell for PUCCH transmission, a number of most significant bits with value set to '0' are inserted to smaller PDSCH-to-HARQ\_feedback timing indicator until the bit width of the PDSCH-to-HARQ\_feedback timing indicator in DCI format 1\_1 associated with the two cells are the same.

If the UE is configured with a PUCCH-SCell, *pucch-sCellDyn* is replaced by *pucch-sCellDynSecondaryPUCCHgroup* for the secondary PUCCH group.

- One-shot HARQ-ACK request – 0 or 1 bit.
  - 1 bit if higher layer parameter *pdsch-HARQ-ACK-OneShotFeedback-r16* or *pdsch-HARQ-ACK-EnhType3ToAddModList* is configured;
  - 0 bit otherwise.

If the UE is configured with a PUCCH-SCell, *pdsch-HARQ-ACK-EnhType3ToAddModList* is replaced by *pdsch-HARQ-ACK-EnhType3SecondaryToAddModList* for the secondary PUCCH group.

- Enhanced Type 3 codebook indicator - 0, 1, 2, or 3 bits.
  - 0 bit if *pdsch-HARQ-ACK-EnhType3DCI-Field* is not configured;
  - $\lceil \log_2(n_{CB}) \rceil$  bits otherwise, where  $n_{CB}$  is the number of entries in the higher layer parameter *pdsch-HARQ-ACK-EnhType3ToAddModList*.

If the UE is configured with a PUCCH-SCell, *pdsch-HARQ-ACK-EnhType3DCI-Field* is replaced by *pdsch-HARQ-ACK-EnhType3DCI-FieldSecondaryPUCCHgroup* for the secondary PUCCH group, and *pdsch-HARQ-ACK-EnhType3ToAddModList* is replaced by *pdsch-HARQ-ACK-EnhType3SecondaryList* for the secondary PUCCH group.

- PDSCH group index – 0 or 1 bit.
  - 1 bit if the higher layer parameter *pdsch-HARQ-ACK-Codebook-r16* = *enhancedDynamic*;
  - 0 bit otherwise.
- New feedback indicator – 0, 1 or 2 bits.

- 1 bit if the higher layer parameter *pdsch-HARQ-ACK-Codebook-r16*= *enhancedDynamic* and the higher layer parameter *nfi-TotalDAI-Included* is not configured;
- 2 bits if the higher layer parameter *pdsch-HARQ-ACK-Codebook-r16*= *enhancedDynamic* and the higher layer parameter *nfi-TotalDAI-Included*=*true*; the MSB corresponds to the scheduled PDSCH group, and the LSB corresponds to the non-scheduled PDSCH group, as defined in [TS38.213] clause 9.1.3.3
- 0 bit otherwise.
- Number of requested PDSCH group(s) – 0 or 1 bit.
  - 1 bit if the higher layer parameter *pdsch-HARQ-ACK-Codebook-r16*= *enhancedDynamic*;
  - 0 bit otherwise.
- HARQ-ACK retransmission indicator – 0 or 1 bit.
  - 1 bit if higher layer parameter *pdsch-HARQ-ACK-Retx* is configured.
  - 0 bit otherwise.

If the UE is configured with a PUCCH-SCell, *pdsch-HARQ-ACK-Retx* is replaced by *pdsch-HARQ-ACK-RetxSecondaryPUCCHgroup* for the secondary PUCCH group.

- Antenna port(s) – 4, 5, or 6 bits as defined by Tables 7.3.1.2.2-1/2/3/4 and Tables 7.3.1.2.2-1A/2A/3A/4A, where the number of CDM groups without data of values 1, 2, and 3 refers to CDM groups {0}, {0,1}, and {0, 1,2} respectively. The antenna ports  $\{p_0, \dots, p_{v-1}\}$  shall be determined according to the ordering of DMRS port(s) given by Tables 7.3.1.2.2-1/2/3/4 or Tables 7.3.1.2.2-1A/2A/3A/4A. When a UE receives an activation command that maps at least one codepoint of DCI field '*Transmission Configuration Indication*' to two TCI states, the UE shall use Table 7.3.1.2.2-1A/2A/3A/4A; otherwise, it shall use Tables 7.3.1.2.2-1/2/3/4. The UE can receive an entry with DMRS ports equals to 1000, 1002, 1003 when two TCI states are indicated in a codepoint of DCI field '*Transmission Configuration Indication*'.

If a UE is configured with both *dmrs-DownlinkForPDSCH-MappingTypeA* and *dmrs-DownlinkForPDSCH-MappingTypeB*, the bitwidth of this field equals  $\max\{x_A, x_B\}$ , where  $x_A$  is the "Antenna ports" bitwidth derived according to *dmrs-DownlinkForPDSCH-MappingTypeA* and  $x_B$  is the "Antenna ports" bitwidth derived according to *dmrs-DownlinkForPDSCH-MappingTypeB*. A number of  $|x_A - x_B|$  zeros are padded in the MSB of this field, if the mapping type of the PDSCH corresponds to the smaller value of  $x_A$  and  $x_B$ .

- Transmission configuration indication – 0 bit if higher layer parameter *tci-PresentInDCI* is not enabled; otherwise 3 bits as defined in Clause 5.1.5 of [6, TS38.214].

If "Bandwidth part indicator" field indicates a bandwidth part other than the active bandwidth part,

- if the higher layer parameter *tci-PresentInDCI* is not enabled for the CORESET used for the PDCCH carrying the DCI format 1\_1,
  - the UE assumes *tci-PresentInDCI* is not enabled for all CORESETs in the indicated bandwidth part;
- otherwise,
  - the UE assumes *tci-PresentInDCI* is enabled for all CORESETs in the indicated bandwidth part.
- SRS request – 2 bits as defined by Table 7.3.1.1.2-24 for UEs not configured with *supplementaryUplink* in *ServingCellConfig* in the cell; 3 bits for UEs configured with *supplementaryUplink* in *ServingCellConfig* in the cell where the first bit is the non-SUL/SUL indicator as defined in Table 7.3.1.1.1-1 and the second and third bits are defined by Table 7.3.1.1.2-24. This bit field may also indicate the associated CSI-RS according to Clause 6.1.1.2 of [6, TS 38.214].
- SRS offset indicator – 0, 1 or 2 bits.
  - 0 bit if higher layer parameter *AvailableSlotOffset* is not configured for any aperiodic SRS resource set in the scheduled cell, or if higher layer parameter *AvailableSlotOffset* is configured for at least one aperiodic SRS



resource set in the scheduled cell and the maximum number of entries of *availableSlotOffsetList* configured for all aperiodic SRS resource set(s) is 1;

- otherwise,  $\lceil \log_2(K) \rceil$  bits are used to indicate available slot offset according to Table 7.3.1.1.2-37 and Clause 6.2.1 of [6, TS 38.214], where  $K$  is the maximum number of entries of *availableSlotOffsetList* configured for all aperiodic SRS resource set(s) in the scheduled cell;
- CBG transmission information (CBGTI) – 0 bit if higher layer parameter *PDSCH-CodeBlockGroupTransmission* for PDSCH is not configured, otherwise, 2, 4, 6, or 8 bits as defined in Clause 5.1.7 of [6, TS38.214], determined by the higher layer parameters *maxCodeBlockGroupsPerTransportBlock* and *maxNrofCodeWordsScheduledByDCI* for the PDSCH.

If higher layer parameter *priorityIndicatorDCI-1-1* is configured, if the bit width of the CBG transmission information in DCI format 1\_1 for one HARQ-ACK codebook is not equal to that of the CBG transmission information in DCI format 1\_1 for the other HARQ-ACK codebook, a number of most significant bits with value set to '0' are inserted to smaller CBG transmission information until the bit width of the CBG transmission information in DCI format 1\_1 for the two HARQ-ACK codebooks are the same.

- CBG flushing out information (CBGFI) – 1 bit if higher layer parameter *codeBlockGroupFlushIndicator* is configured as "TRUE", 0 bit otherwise.

If higher layer parameter *priorityIndicatorDCI-1-1* is configured, if the bit width of the CBG flushing out information in DCI format 1\_1 for one HARQ-ACK codebook is not equal to that of the CBG flushing out information in DCI format 1\_1 for the other HARQ-ACK codebook, a number of most significant bits with value set to '0' are inserted to smaller CBG flushing out information until the bit width of the CBG flushing out information in DCI format 1\_1 for the two HARQ-ACK codebooks are the same.

- DMRS sequence initialization – 1 bit.
- Priority indicator – 0 bit if higher layer parameter *priorityIndicatorDCI-1-1* is not configured; otherwise 1 bit as defined in Clause 9 in [5, TS 38.213].
- ChannelAccess-CPext – 0, 1, 2, 3 or 4 bits. The bitwidth for this field is determined as  $\lceil \log_2(I) \rceil$  bits, where  $I$  is the number of entries in the higher layer parameter *ul-AccessConfigListDCI-1-1* or in Table 7.3.1.1.1-4A if *channelAccessMode-r16* = "semiStatic" is provided, for operation in a cell with shared spectrum channel access in frequency range 1, or for operation in frequency range 2-2 if *ChannelAccessMode2-r17* is provided; otherwise 0 bit. One or more entries from Table 7.3.1.2.2-6 or Table 7.3.1.2.2-6A are configured by the higher layer parameter *ul-AccessConfigListDCI-1-1*.
- Minimum applicable scheduling offset indicator – 0 or 1 bit
  - 0 bit if higher layer parameter *minimumSchedulingOffsetK0* is not configured;
  - 1 bit if higher layer parameter *minimumSchedulingOffsetK0* is configured. The 1 bit indication is used to determine the minimum applicable K0 for the active DL BWP and the minimum applicable K2 value for the active UL BWP, if configured respectively, according to Table 7.3.1.1.2-33. If the minimum applicable K0 is indicated, the minimum applicable value of the aperiodic CSI-RS triggering offset for an active DL BWP shall be the same as the minimum applicable K0 value.
- SCell dormancy indication – 0 bit if higher layer parameter *dormancyGroupWithinActiveTime* is not configured; otherwise 1, 2, 3, 4 or 5 bits bitmap determined according to the number of different *DormancyGroupID(s)* provided by higher layer parameter *dormancyGroupWithinActiveTime*, where each bit corresponds to one of the SCell group(s) configured by higher layers parameter *dormancyGroupWithinActiveTime*, with MSB to LSB of the bitmap corresponding to the first to last configured SCell group in ascending order of *DormancyGroupID*. The field is only present when this format is carried by PDCCH on the primary cell within DRX Active Time and the UE is configured with at least two DL BWPs for an SCell.

If one-shot HARQ-ACK request is not present or set to '0', and all bits of frequency domain resource assignment are set to 0 for resource allocation type 0 or set to 1 for resource allocation type 1 or set to 0 or 1 for dynamic switch resource allocation type, this field is reserved and the following fields among the fields above are used for SCell dormancy indication, where each bit corresponds to one of the configured SCell(s), with MSB to LSB of the following fields concatenated in the order below corresponding to the SCell with lowest to highest SCell index

- Modulation and coding scheme of transport block 1
- New data indicator of transport block 1
- Redundancy version of transport block 1
- HARQ process number
- Antenna port(s)
- DMRS sequence initialization
- PDCCH monitoring adaptation indication – 0, 1 or 2 bits
  - 1 or 2 bits, if *searchSpaceGroupIdList-r17* is not configured and if *pdccch-SkippingDurationList* is configured
    - 1 bit if the UE is configured with only one duration by *pdccch-SkippingDurationList*;
    - 2 bits if the UE is configured with more than one duration by *pdccch-SkippingDurationList*.
  - 1 or 2 bits, if *pdccch-SkippingDurationList* is not configured and if *searchSpaceGroupIdList-r17* is configured
    - 1 bit if the UE is configured by *searchSpaceGroupIdList-r17* with search space set(s) with group index 0 and search space set(s) with group index 1, and if the UE is not configured by *searchSpaceGroupIdList-r17* with any search space set with group index 2;
    - 2 bits if the UE is configured by *searchSpaceGroupIdList-r17* with search space set(s) with group index 0, search space set(s) with group index 1 and search space set(s) with group index 2;
  - 2 bits, if *pdccch-SkippingDurationList* is configured and if *searchSpaceGroupIdList-r17* is configured
  - 0 bit, otherwise
- PUCCH Cell indicator – 0 or 1 bit.
  - 1 bit if higher layer parameter *pucch-sSCellDyn* is configured.
  - 0 bit otherwise.

If the UE is configured with a PUCCH-SCell, *pucch-sSCellDyn* is replaced by *pucch-sSCellDynSecondaryPUCCHgroup* for the secondary PUCCH group.

If DCI formats 1\_1 are monitored in multiple search spaces associated with multiple CORESETs in a BWP for scheduling the same serving cell, zeros shall be appended until the payload size of the DCI formats 1\_1 monitored in the multiple search spaces equal to the maximum payload size of the DCI format 1\_1 monitored in the multiple search spaces.

If the number of information bits in DCI format 1\_1 scheduling a single PDSCH prior to padding is not equal to the number of information bits in DCI format 1\_1 scheduling multiple PDSCHs for the same serving cell, zeros shall be appended to the DCI format 1\_1 with smaller size until the payload size is the same for scheduling a single PDSCH and multiple PDSCHs.

For a UE configured with scheduling on the primary cell from an SCell, if prior to padding the number of information bits in DCI format 1\_1 carried by PDCCH on the primary cell is not equal to the number of information bits in DCI format 1\_1 carried by PDCCH on the SCell for scheduling on the primary cell, zeros shall be appended to the DCI format 1\_1 with smaller size until the payload size is the same.

- If application of step 4C in clause 7.3.1.0 results in additional zero padding for DCI format 1\_1 for scheduling on the primary cell, corresponding zeros shall be appended to both DCI format 1\_1 monitored on the primary cell and DCI format 1\_1 monitored on the SCell for scheduling on the primary cell.
- If the SCell is deactivated and *firstActiveDownlinkBWP-Id* is not set to dormant BWP, the UE determines the number of information bits in DCI format 1\_1 carried by PDCCH on the primary cell based on a DL BWP provided by *firstActiveDownlinkBWP-Id* for the SCell. If the active DL BWP of the SCell is a dormant DL BWP, or if the SCell is deactivated and *firstActiveDownlinkBWP-Id* is set to dormant BWP, the UE determines the number of information bits in DCI format 1\_1 carried by PDCCH on the primary cell based on a DL BWP

provided by *firstWithinActiveTimeBWP-Id* for the SCell if provided; otherwise, based on a DL BWP provided by *firstOutsideActiveTimeBWP-Id* for the SCell.

**Table 7.3.1.2.2-1: Antenna port(s) (1000 + DMRS port), *dmrs-Type*=1, *maxLength*=1**

| One Codeword:<br>Codeword 0 enabled,<br>Codeword 1 disabled |                                                |                 |
|-------------------------------------------------------------|------------------------------------------------|-----------------|
| Value                                                       | Number of DMRS<br>CDM group(s)<br>without data | DMRS<br>port(s) |
| 0                                                           | 1                                              | 0               |
| 1                                                           | 1                                              | 1               |
| 2                                                           | 1                                              | 0,1             |
| 3                                                           | 2                                              | 0               |
| 4                                                           | 2                                              | 1               |
| 5                                                           | 2                                              | 2               |
| 6                                                           | 2                                              | 3               |
| 7                                                           | 2                                              | 0,1             |
| 8                                                           | 2                                              | 2,3             |
| 9                                                           | 2                                              | 0-2             |
| 10                                                          | 2                                              | 0-3             |
| 11                                                          | 2                                              | 0,2             |
| 12-15                                                       | Reserved                                       | Reserved        |

**Table 7.3.1.2.2-1A: Antenna port(s) (1000 + DMRS port), *dmrs-Type*=1, *maxLength*=1**

| One Codeword:<br>Codeword 0 enabled,<br>Codeword 1 disabled |                                                |                 |
|-------------------------------------------------------------|------------------------------------------------|-----------------|
| Value                                                       | Number of DMRS<br>CDM group(s)<br>without data | DMRS<br>port(s) |
| 0                                                           | 1                                              | 0               |
| 1                                                           | 1                                              | 1               |
| 2                                                           | 1                                              | 0,1             |
| 3                                                           | 2                                              | 0               |
| 4                                                           | 2                                              | 1               |
| 5                                                           | 2                                              | 2               |
| 6                                                           | 2                                              | 3               |
| 7                                                           | 2                                              | 0,1             |
| 8                                                           | 2                                              | 2,3             |
| 9                                                           | 2                                              | 0-2             |
| 10                                                          | 2                                              | 0-3             |
| 11                                                          | 2                                              | 0,2             |
| 12                                                          | 2                                              | 0,2,3           |
| 13-15                                                       | Reserved                                       | Reserved        |

Table 7.3.1.2.2-2: Antenna port(s) (1000 + DMRS port), *dmrs-Type*=1, *maxLength*=2

| One Codeword:<br>Codeword 0 enabled,<br>Codeword 1 disabled |                                                   |                 |                                    | Two Codewords:<br>Codeword 0 enabled,<br>Codeword 1 enabled |                                                   |                 |                                    |
|-------------------------------------------------------------|---------------------------------------------------|-----------------|------------------------------------|-------------------------------------------------------------|---------------------------------------------------|-----------------|------------------------------------|
| Value                                                       | Number of<br>DMRS CDM<br>group(s)<br>without data | DMRS<br>port(s) | Number of<br>front-load<br>symbols | Value                                                       | Number of<br>DMRS CDM<br>group(s)<br>without data | DMRS port(s)    | Number of<br>front-load<br>symbols |
| 0                                                           | 1                                                 | 0               | 1                                  | 0                                                           | 2                                                 | 0-4             | 2                                  |
| 1                                                           | 1                                                 | 1               | 1                                  | 1                                                           | 2                                                 | 0,1,2,3,4,6     | 2                                  |
| 2                                                           | 1                                                 | 0,1             | 1                                  | 2                                                           | 2                                                 | 0,1,2,3,4,5,6   | 2                                  |
| 3                                                           | 2                                                 | 0               | 1                                  | 3                                                           | 2                                                 | 0,1,2,3,4,5,6,7 | 2                                  |
| 4                                                           | 2                                                 | 1               | 1                                  | 4-31                                                        | reserved                                          | reserved        | reserved                           |
| 5                                                           | 2                                                 | 2               | 1                                  |                                                             |                                                   |                 |                                    |
| 6                                                           | 2                                                 | 3               | 1                                  |                                                             |                                                   |                 |                                    |
| 7                                                           | 2                                                 | 0,1             | 1                                  |                                                             |                                                   |                 |                                    |
| 8                                                           | 2                                                 | 2,3             | 1                                  |                                                             |                                                   |                 |                                    |
| 9                                                           | 2                                                 | 0-2             | 1                                  |                                                             |                                                   |                 |                                    |
| 10                                                          | 2                                                 | 0-3             | 1                                  |                                                             |                                                   |                 |                                    |
| 11                                                          | 2                                                 | 0,2             | 1                                  |                                                             |                                                   |                 |                                    |
| 12                                                          | 2                                                 | 0               | 2                                  |                                                             |                                                   |                 |                                    |
| 13                                                          | 2                                                 | 1               | 2                                  |                                                             |                                                   |                 |                                    |
| 14                                                          | 2                                                 | 2               | 2                                  |                                                             |                                                   |                 |                                    |
| 15                                                          | 2                                                 | 3               | 2                                  |                                                             |                                                   |                 |                                    |
| 16                                                          | 2                                                 | 4               | 2                                  |                                                             |                                                   |                 |                                    |
| 17                                                          | 2                                                 | 5               | 2                                  |                                                             |                                                   |                 |                                    |
| 18                                                          | 2                                                 | 6               | 2                                  |                                                             |                                                   |                 |                                    |
| 19                                                          | 2                                                 | 7               | 2                                  |                                                             |                                                   |                 |                                    |
| 20                                                          | 2                                                 | 0,1             | 2                                  |                                                             |                                                   |                 |                                    |
| 21                                                          | 2                                                 | 2,3             | 2                                  |                                                             |                                                   |                 |                                    |
| 22                                                          | 2                                                 | 4,5             | 2                                  |                                                             |                                                   |                 |                                    |
| 23                                                          | 2                                                 | 6,7             | 2                                  |                                                             |                                                   |                 |                                    |
| 24                                                          | 2                                                 | 0,4             | 2                                  |                                                             |                                                   |                 |                                    |
| 25                                                          | 2                                                 | 2,6             | 2                                  |                                                             |                                                   |                 |                                    |
| 26                                                          | 2                                                 | 0,1,4           | 2                                  |                                                             |                                                   |                 |                                    |
| 27                                                          | 2                                                 | 2,3,6           | 2                                  |                                                             |                                                   |                 |                                    |
| 28                                                          | 2                                                 | 0,1,4,5         | 2                                  |                                                             |                                                   |                 |                                    |
| 29                                                          | 2                                                 | 2,3,6,7         | 2                                  |                                                             |                                                   |                 |                                    |
| 30                                                          | 2                                                 | 0,2,4,6         | 2                                  |                                                             |                                                   |                 |                                    |
| 31                                                          | Reserved                                          | Reserved        | Reserved                           |                                                             |                                                   |                 |                                    |

Table 7.3.1.2.2-2A: Antenna port(s) (1000 + DMRS port), *dmrs-Type*=1, *maxLength*=2

| One Codeword:<br>Codeword 0 enabled,<br>Codeword 1 disabled |                                                   |                 |                                    | Two Codewords:<br>Codeword 0 enabled,<br>Codeword 1 enabled |                                                   |                 |                                    |
|-------------------------------------------------------------|---------------------------------------------------|-----------------|------------------------------------|-------------------------------------------------------------|---------------------------------------------------|-----------------|------------------------------------|
| Value                                                       | Number of<br>DMRS CDM<br>group(s)<br>without data | DMRS<br>port(s) | Number of<br>front-load<br>symbols | Value                                                       | Number of<br>DMRS CDM<br>group(s)<br>without data | DMRS port(s)    | Number of<br>front-load<br>symbols |
| 0                                                           | 1                                                 | 0               | 1                                  | 0                                                           | 2                                                 | 0-4             | 2                                  |
| 1                                                           | 1                                                 | 1               | 1                                  | 1                                                           | 2                                                 | 0,1,2,3,4,6     | 2                                  |
| 2                                                           | 1                                                 | 0,1             | 1                                  | 2                                                           | 2                                                 | 0,1,2,3,4,5,6   | 2                                  |
| 3                                                           | 2                                                 | 0               | 1                                  | 3                                                           | 2                                                 | 0,1,2,3,4,5,6,7 | 2                                  |
| 4                                                           | 2                                                 | 1               | 1                                  | 4-31                                                        | reserved                                          | reserved        | reserved                           |
| 5                                                           | 2                                                 | 2               | 1                                  |                                                             |                                                   |                 |                                    |
| 6                                                           | 2                                                 | 3               | 1                                  |                                                             |                                                   |                 |                                    |
| 7                                                           | 2                                                 | 0,1             | 1                                  |                                                             |                                                   |                 |                                    |
| 8                                                           | 2                                                 | 2,3             | 1                                  |                                                             |                                                   |                 |                                    |
| 9                                                           | 2                                                 | 0-2             | 1                                  |                                                             |                                                   |                 |                                    |
| 10                                                          | 2                                                 | 0-3             | 1                                  |                                                             |                                                   |                 |                                    |
| 11                                                          | 2                                                 | 0,2             | 1                                  |                                                             |                                                   |                 |                                    |
| 12                                                          | 2                                                 | 0               | 2                                  |                                                             |                                                   |                 |                                    |
| 13                                                          | 2                                                 | 1               | 2                                  |                                                             |                                                   |                 |                                    |
| 14                                                          | 2                                                 | 2               | 2                                  |                                                             |                                                   |                 |                                    |
| 15                                                          | 2                                                 | 3               | 2                                  |                                                             |                                                   |                 |                                    |
| 16                                                          | 2                                                 | 4               | 2                                  |                                                             |                                                   |                 |                                    |
| 17                                                          | 2                                                 | 5               | 2                                  |                                                             |                                                   |                 |                                    |
| 18                                                          | 2                                                 | 6               | 2                                  |                                                             |                                                   |                 |                                    |
| 19                                                          | 2                                                 | 7               | 2                                  |                                                             |                                                   |                 |                                    |
| 20                                                          | 2                                                 | 0,1             | 2                                  |                                                             |                                                   |                 |                                    |
| 21                                                          | 2                                                 | 2,3             | 2                                  |                                                             |                                                   |                 |                                    |
| 22                                                          | 2                                                 | 4,5             | 2                                  |                                                             |                                                   |                 |                                    |
| 23                                                          | 2                                                 | 6,7             | 2                                  |                                                             |                                                   |                 |                                    |
| 24                                                          | 2                                                 | 0,4             | 2                                  |                                                             |                                                   |                 |                                    |
| 25                                                          | 2                                                 | 2,6             | 2                                  |                                                             |                                                   |                 |                                    |
| 26                                                          | 2                                                 | 0,1,4           | 2                                  |                                                             |                                                   |                 |                                    |
| 27                                                          | 2                                                 | 2,3,6           | 2                                  |                                                             |                                                   |                 |                                    |
| 28                                                          | 2                                                 | 0,1,4,5         | 2                                  |                                                             |                                                   |                 |                                    |
| 29                                                          | 2                                                 | 2,3,6,7         | 2                                  |                                                             |                                                   |                 |                                    |
| 30                                                          | 2                                                 | 0,2,4,6         | 2                                  |                                                             |                                                   |                 |                                    |
| 31                                                          | 2                                                 | 0,2,3           | 1                                  |                                                             |                                                   |                 |                                    |

Table 7.3.1.2.2-3: Antenna port(s) (1000 + DMRS port), *dmrs-Type*=2, *maxLength*=1

| One codeword:<br>Codeword 0 enabled,<br>Codeword 1 disabled |                                                   |                 | Two codewords:<br>Codeword 0 enabled,<br>Codeword 1 enabled |                                                   |              |
|-------------------------------------------------------------|---------------------------------------------------|-----------------|-------------------------------------------------------------|---------------------------------------------------|--------------|
| Value                                                       | Number of<br>DMRS CDM<br>group(s)<br>without data | DMRS<br>port(s) | Value                                                       | Number of<br>DMRS CDM<br>group(s)<br>without data | DMRS port(s) |
| 0                                                           | 1                                                 | 0               | 0                                                           | 3                                                 | 0-4          |
| 1                                                           | 1                                                 | 1               | 1                                                           | 3                                                 | 0-5          |
| 2                                                           | 1                                                 | 0,1             | 2-31                                                        | reserved                                          | reserved     |
| 3                                                           | 2                                                 | 0               |                                                             |                                                   |              |
| 4                                                           | 2                                                 | 1               |                                                             |                                                   |              |
| 5                                                           | 2                                                 | 2               |                                                             |                                                   |              |
| 6                                                           | 2                                                 | 3               |                                                             |                                                   |              |
| 7                                                           | 2                                                 | 0,1             |                                                             |                                                   |              |
| 8                                                           | 2                                                 | 2,3             |                                                             |                                                   |              |
| 9                                                           | 2                                                 | 0-2             |                                                             |                                                   |              |
| 10                                                          | 2                                                 | 0-3             |                                                             |                                                   |              |
| 11                                                          | 3                                                 | 0               |                                                             |                                                   |              |
| 12                                                          | 3                                                 | 1               |                                                             |                                                   |              |
| 13                                                          | 3                                                 | 2               |                                                             |                                                   |              |
| 14                                                          | 3                                                 | 3               |                                                             |                                                   |              |
| 15                                                          | 3                                                 | 4               |                                                             |                                                   |              |
| 16                                                          | 3                                                 | 5               |                                                             |                                                   |              |
| 17                                                          | 3                                                 | 0,1             |                                                             |                                                   |              |
| 18                                                          | 3                                                 | 2,3             |                                                             |                                                   |              |
| 19                                                          | 3                                                 | 4,5             |                                                             |                                                   |              |
| 20                                                          | 3                                                 | 0-2             |                                                             |                                                   |              |
| 21                                                          | 3                                                 | 3-5             |                                                             |                                                   |              |
| 22                                                          | 3                                                 | 0-3             |                                                             |                                                   |              |
| 23                                                          | 2                                                 | 0,2             |                                                             |                                                   |              |
| 24-31                                                       | Reserved                                          | Reserved        |                                                             |                                                   |              |

**Table 7.3.1.2.2-3A: Antenna port(s) (1000 + DMRS port), *dmrs-Type=2*, *maxLength=1***

| One codeword:<br>Codeword 0 enabled,<br>Codeword 1 disabled |                                                   |                 | Two codewords:<br>Codeword 0 enabled,<br>Codeword 1 enabled |                                                   |              |
|-------------------------------------------------------------|---------------------------------------------------|-----------------|-------------------------------------------------------------|---------------------------------------------------|--------------|
| Value                                                       | Number of<br>DMRS CDM<br>group(s)<br>without data | DMRS<br>port(s) | Value                                                       | Number of<br>DMRS CDM<br>group(s)<br>without data | DMRS port(s) |
| 0                                                           | 1                                                 | 0               | 0                                                           | 3                                                 | 0-4          |
| 1                                                           | 1                                                 | 1               | 1                                                           | 3                                                 | 0-5          |
| 2                                                           | 1                                                 | 0,1             | 2-31                                                        | reserved                                          | reserved     |
| 3                                                           | 2                                                 | 0               |                                                             |                                                   |              |
| 4                                                           | 2                                                 | 1               |                                                             |                                                   |              |
| 5                                                           | 2                                                 | 2               |                                                             |                                                   |              |
| 6                                                           | 2                                                 | 3               |                                                             |                                                   |              |
| 7                                                           | 2                                                 | 0,1             |                                                             |                                                   |              |
| 8                                                           | 2                                                 | 2,3             |                                                             |                                                   |              |
| 9                                                           | 2                                                 | 0-2             |                                                             |                                                   |              |
| 10                                                          | 2                                                 | 0-3             |                                                             |                                                   |              |
| 11                                                          | 3                                                 | 0               |                                                             |                                                   |              |
| 12                                                          | 3                                                 | 1               |                                                             |                                                   |              |
| 13                                                          | 3                                                 | 2               |                                                             |                                                   |              |
| 14                                                          | 3                                                 | 3               |                                                             |                                                   |              |
| 15                                                          | 3                                                 | 4               |                                                             |                                                   |              |
| 16                                                          | 3                                                 | 5               |                                                             |                                                   |              |
| 17                                                          | 3                                                 | 0,1             |                                                             |                                                   |              |
| 18                                                          | 3                                                 | 2,3             |                                                             |                                                   |              |
| 19                                                          | 3                                                 | 4,5             |                                                             |                                                   |              |
| 20                                                          | 3                                                 | 0-2             |                                                             |                                                   |              |
| 21                                                          | 3                                                 | 3-5             |                                                             |                                                   |              |
| 22                                                          | 3                                                 | 0-3             |                                                             |                                                   |              |
| 23                                                          | 2                                                 | 0,2             |                                                             |                                                   |              |
| 24                                                          | 2                                                 | 0,2,3           |                                                             |                                                   |              |
| 25-31                                                       | Reserved                                          | Reserved        |                                                             |                                                   |              |

Table 7.3.1.2.2-4: Antenna port(s) (1000 + DMRS port), *dmrs-Type*=2, *maxLength*=2



| One codeword:<br>Codeword 0 enabled,<br>Codeword 1 disabled |                                                   |                 |                                    | Two Codewords:<br>Codeword 0 enabled,<br>Codeword 1 enabled |                                                   |                 |                                    |
|-------------------------------------------------------------|---------------------------------------------------|-----------------|------------------------------------|-------------------------------------------------------------|---------------------------------------------------|-----------------|------------------------------------|
| Value                                                       | Number of<br>DMRS CDM<br>group(s)<br>without data | DMRS<br>port(s) | Number of<br>front-load<br>symbols | Value                                                       | Number of<br>DMRS CDM<br>group(s)<br>without data | DMRS port(s)    | Number of<br>front-load<br>symbols |
| 0                                                           | 1                                                 | 0               | 1                                  | 0                                                           | 3                                                 | 0-4             | 1                                  |
| 1                                                           | 1                                                 | 1               | 1                                  | 1                                                           | 3                                                 | 0-5             | 1                                  |
| 2                                                           | 1                                                 | 0,1             | 1                                  | 2                                                           | 2                                                 | 0,1,2,3,6       | 2                                  |
| 3                                                           | 2                                                 | 0               | 1                                  | 3                                                           | 2                                                 | 0,1,2,3,6,8     | 2                                  |
| 4                                                           | 2                                                 | 1               | 1                                  | 4                                                           | 2                                                 | 0,1,2,3,6,7,8   | 2                                  |
| 5                                                           | 2                                                 | 2               | 1                                  | 5                                                           | 2                                                 | 0,1,2,3,6,7,8,9 | 2                                  |
| 6                                                           | 2                                                 | 3               | 1                                  | 6-63                                                        | Reserved                                          | Reserved        | Reserved                           |
| 7                                                           | 2                                                 | 0,1             | 1                                  |                                                             |                                                   |                 |                                    |
| 8                                                           | 2                                                 | 2,3             | 1                                  |                                                             |                                                   |                 |                                    |
| 9                                                           | 2                                                 | 0-2             | 1                                  |                                                             |                                                   |                 |                                    |
| 10                                                          | 2                                                 | 0-3             | 1                                  |                                                             |                                                   |                 |                                    |
| 11                                                          | 3                                                 | 0               | 1                                  |                                                             |                                                   |                 |                                    |
| 12                                                          | 3                                                 | 1               | 1                                  |                                                             |                                                   |                 |                                    |
| 13                                                          | 3                                                 | 2               | 1                                  |                                                             |                                                   |                 |                                    |
| 14                                                          | 3                                                 | 3               | 1                                  |                                                             |                                                   |                 |                                    |
| 15                                                          | 3                                                 | 4               | 1                                  |                                                             |                                                   |                 |                                    |
| 16                                                          | 3                                                 | 5               | 1                                  |                                                             |                                                   |                 |                                    |
| 17                                                          | 3                                                 | 0,1             | 1                                  |                                                             |                                                   |                 |                                    |
| 18                                                          | 3                                                 | 2,3             | 1                                  |                                                             |                                                   |                 |                                    |
| 19                                                          | 3                                                 | 4,5             | 1                                  |                                                             |                                                   |                 |                                    |
| 20                                                          | 3                                                 | 0-2             | 1                                  |                                                             |                                                   |                 |                                    |
| 21                                                          | 3                                                 | 3-5             | 1                                  |                                                             |                                                   |                 |                                    |
| 22                                                          | 3                                                 | 0-3             | 1                                  |                                                             |                                                   |                 |                                    |
| 23                                                          | 2                                                 | 0,2             | 1                                  |                                                             |                                                   |                 |                                    |
| 24                                                          | 3                                                 | 0               | 2                                  |                                                             |                                                   |                 |                                    |
| 25                                                          | 3                                                 | 1               | 2                                  |                                                             |                                                   |                 |                                    |
| 26                                                          | 3                                                 | 2               | 2                                  |                                                             |                                                   |                 |                                    |
| 27                                                          | 3                                                 | 3               | 2                                  |                                                             |                                                   |                 |                                    |
| 28                                                          | 3                                                 | 4               | 2                                  |                                                             |                                                   |                 |                                    |
| 29                                                          | 3                                                 | 5               | 2                                  |                                                             |                                                   |                 |                                    |
| 30                                                          | 3                                                 | 6               | 2                                  |                                                             |                                                   |                 |                                    |
| 31                                                          | 3                                                 | 7               | 2                                  |                                                             |                                                   |                 |                                    |
| 32                                                          | 3                                                 | 8               | 2                                  |                                                             |                                                   |                 |                                    |
| 33                                                          | 3                                                 | 9               | 2                                  |                                                             |                                                   |                 |                                    |
| 34                                                          | 3                                                 | 10              | 2                                  |                                                             |                                                   |                 |                                    |
| 35                                                          | 3                                                 | 11              | 2                                  |                                                             |                                                   |                 |                                    |
| 36                                                          | 3                                                 | 0,1             | 2                                  |                                                             |                                                   |                 |                                    |
| 37                                                          | 3                                                 | 2,3             | 2                                  |                                                             |                                                   |                 |                                    |
| 38                                                          | 3                                                 | 4,5             | 2                                  |                                                             |                                                   |                 |                                    |
| 39                                                          | 3                                                 | 6,7             | 2                                  |                                                             |                                                   |                 |                                    |
| 40                                                          | 3                                                 | 8,9             | 2                                  |                                                             |                                                   |                 |                                    |
| 41                                                          | 3                                                 | 10,11           | 2                                  |                                                             |                                                   |                 |                                    |
| 42                                                          | 3                                                 | 0,1,6           | 2                                  |                                                             |                                                   |                 |                                    |
| 43                                                          | 3                                                 | 2,3,8           | 2                                  |                                                             |                                                   |                 |                                    |
| 44                                                          | 3                                                 | 4,5,10          | 2                                  |                                                             |                                                   |                 |                                    |
| 45                                                          | 3                                                 | 0,1,6,7         | 2                                  |                                                             |                                                   |                 |                                    |
| 46                                                          | 3                                                 | 2,3,8,9         | 2                                  |                                                             |                                                   |                 |                                    |
| 47                                                          | 3                                                 | 4,5,10,11       | 2                                  |                                                             |                                                   |                 |                                    |
| 48                                                          | 1                                                 | 0               | 2                                  |                                                             |                                                   |                 |                                    |
| 49                                                          | 1                                                 | 1               | 2                                  |                                                             |                                                   |                 |                                    |
| 50                                                          | 1                                                 | 6               | 2                                  |                                                             |                                                   |                 |                                    |
| 51                                                          | 1                                                 | 7               | 2                                  |                                                             |                                                   |                 |                                    |
| 52                                                          | 1                                                 | 0,1             | 2                                  |                                                             |                                                   |                 |                                    |
| 53                                                          | 1                                                 | 6,7             | 2                                  |                                                             |                                                   |                 |                                    |
| 54                                                          | 2                                                 | 0,1             | 2                                  |                                                             |                                                   |                 |                                    |
| 55                                                          | 2                                                 | 2,3             | 2                                  |                                                             |                                                   |                 |                                    |
| 56                                                          | 2                                                 | 6,7             | 2                                  |                                                             |                                                   |                 |                                    |

|       |          |          |          |  |  |  |  |
|-------|----------|----------|----------|--|--|--|--|
| 57    | 2        | 8,9      | 2        |  |  |  |  |
| 58-63 | Reserved | Reserved | Reserved |  |  |  |  |

Table 7.3.1.2.2-4A: Antenna port(s) (1000 + DMRS port), *dmrs-Type*=2, *maxLength*=2

| One codeword:<br>Codeword 0 enabled,<br>Codeword 1 disabled |                                                   |                 |                                    | Two Codewords:<br>Codeword 0 enabled,<br>Codeword 1 enabled |                                                   |                 |                                    |
|-------------------------------------------------------------|---------------------------------------------------|-----------------|------------------------------------|-------------------------------------------------------------|---------------------------------------------------|-----------------|------------------------------------|
| Value                                                       | Number of<br>DMRS CDM<br>group(s)<br>without data | DMRS<br>port(s) | Number of<br>front-load<br>symbols | Value                                                       | Number of<br>DMRS CDM<br>group(s)<br>without data | DMRS port(s)    | Number of<br>front-load<br>symbols |
| 0                                                           | 1                                                 | 0               | 1                                  | 0                                                           | 3                                                 | 0-4             | 1                                  |
| 1                                                           | 1                                                 | 1               | 1                                  | 1                                                           | 3                                                 | 0-5             | 1                                  |
| 2                                                           | 1                                                 | 0,1             | 1                                  | 2                                                           | 2                                                 | 0,1,2,3,6       | 2                                  |
| 3                                                           | 2                                                 | 0               | 1                                  | 3                                                           | 2                                                 | 0,1,2,3,6,8     | 2                                  |
| 4                                                           | 2                                                 | 1               | 1                                  | 4                                                           | 2                                                 | 0,1,2,3,6,7,8   | 2                                  |
| 5                                                           | 2                                                 | 2               | 1                                  | 5                                                           | 2                                                 | 0,1,2,3,6,7,8,9 | 2                                  |
| 6                                                           | 2                                                 | 3               | 1                                  | 6-63                                                        | Reserved                                          | Reserved        | Reserved                           |
| 7                                                           | 2                                                 | 0,1             | 1                                  |                                                             |                                                   |                 |                                    |
| 8                                                           | 2                                                 | 2,3             | 1                                  |                                                             |                                                   |                 |                                    |
| 9                                                           | 2                                                 | 0-2             | 1                                  |                                                             |                                                   |                 |                                    |
| 10                                                          | 2                                                 | 0-3             | 1                                  |                                                             |                                                   |                 |                                    |
| 11                                                          | 3                                                 | 0               | 1                                  |                                                             |                                                   |                 |                                    |
| 12                                                          | 3                                                 | 1               | 1                                  |                                                             |                                                   |                 |                                    |
| 13                                                          | 3                                                 | 2               | 1                                  |                                                             |                                                   |                 |                                    |
| 14                                                          | 3                                                 | 3               | 1                                  |                                                             |                                                   |                 |                                    |
| 15                                                          | 3                                                 | 4               | 1                                  |                                                             |                                                   |                 |                                    |
| 16                                                          | 3                                                 | 5               | 1                                  |                                                             |                                                   |                 |                                    |
| 17                                                          | 3                                                 | 0,1             | 1                                  |                                                             |                                                   |                 |                                    |
| 18                                                          | 3                                                 | 2,3             | 1                                  |                                                             |                                                   |                 |                                    |
| 19                                                          | 3                                                 | 4,5             | 1                                  |                                                             |                                                   |                 |                                    |
| 20                                                          | 3                                                 | 0-2             | 1                                  |                                                             |                                                   |                 |                                    |
| 21                                                          | 3                                                 | 3-5             | 1                                  |                                                             |                                                   |                 |                                    |
| 22                                                          | 3                                                 | 0-3             | 1                                  |                                                             |                                                   |                 |                                    |
| 23                                                          | 2                                                 | 0,2             | 1                                  |                                                             |                                                   |                 |                                    |
| 24                                                          | 3                                                 | 0               | 2                                  |                                                             |                                                   |                 |                                    |
| 25                                                          | 3                                                 | 1               | 2                                  |                                                             |                                                   |                 |                                    |
| 26                                                          | 3                                                 | 2               | 2                                  |                                                             |                                                   |                 |                                    |
| 27                                                          | 3                                                 | 3               | 2                                  |                                                             |                                                   |                 |                                    |
| 28                                                          | 3                                                 | 4               | 2                                  |                                                             |                                                   |                 |                                    |
| 29                                                          | 3                                                 | 5               | 2                                  |                                                             |                                                   |                 |                                    |
| 30                                                          | 3                                                 | 6               | 2                                  |                                                             |                                                   |                 |                                    |
| 31                                                          | 3                                                 | 7               | 2                                  |                                                             |                                                   |                 |                                    |
| 32                                                          | 3                                                 | 8               | 2                                  |                                                             |                                                   |                 |                                    |
| 33                                                          | 3                                                 | 9               | 2                                  |                                                             |                                                   |                 |                                    |
| 34                                                          | 3                                                 | 10              | 2                                  |                                                             |                                                   |                 |                                    |
| 35                                                          | 3                                                 | 11              | 2                                  |                                                             |                                                   |                 |                                    |
| 36                                                          | 3                                                 | 0,1             | 2                                  |                                                             |                                                   |                 |                                    |
| 37                                                          | 3                                                 | 2,3             | 2                                  |                                                             |                                                   |                 |                                    |
| 38                                                          | 3                                                 | 4,5             | 2                                  |                                                             |                                                   |                 |                                    |
| 39                                                          | 3                                                 | 6,7             | 2                                  |                                                             |                                                   |                 |                                    |
| 40                                                          | 3                                                 | 8,9             | 2                                  |                                                             |                                                   |                 |                                    |
| 41                                                          | 3                                                 | 10,11           | 2                                  |                                                             |                                                   |                 |                                    |
| 42                                                          | 3                                                 | 0,1,6           | 2                                  |                                                             |                                                   |                 |                                    |
| 43                                                          | 3                                                 | 2,3,8           | 2                                  |                                                             |                                                   |                 |                                    |
| 44                                                          | 3                                                 | 4,5,10          | 2                                  |                                                             |                                                   |                 |                                    |
| 45                                                          | 3                                                 | 0,1,6,7         | 2                                  |                                                             |                                                   |                 |                                    |
| 46                                                          | 3                                                 | 2,3,8,9         | 2                                  |                                                             |                                                   |                 |                                    |
| 47                                                          | 3                                                 | 4,5,10,11       | 2                                  |                                                             |                                                   |                 |                                    |
| 48                                                          | 1                                                 | 0               | 2                                  |                                                             |                                                   |                 |                                    |
| 49                                                          | 1                                                 | 1               | 2                                  |                                                             |                                                   |                 |                                    |
| 50                                                          | 1                                                 | 6               | 2                                  |                                                             |                                                   |                 |                                    |
| 51                                                          | 1                                                 | 7               | 2                                  |                                                             |                                                   |                 |                                    |
| 52                                                          | 1                                                 | 0,1             | 2                                  |                                                             |                                                   |                 |                                    |
| 53                                                          | 1                                                 | 6,7             | 2                                  |                                                             |                                                   |                 |                                    |
| 54                                                          | 2                                                 | 0,1             | 2                                  |                                                             |                                                   |                 |                                    |
| 55                                                          | 2                                                 | 2,3             | 2                                  |                                                             |                                                   |                 |                                    |
| 56                                                          | 2                                                 | 6,7             | 2                                  |                                                             |                                                   |                 |                                    |

|       |          |          |          |  |  |  |  |
|-------|----------|----------|----------|--|--|--|--|
| 57    | 2        | 8,9      | 2        |  |  |  |  |
| 58    | 2        | 0,2,3    | 1        |  |  |  |  |
| 59-63 | Reserved | Reserved | Reserved |  |  |  |  |

Table 7.3.1.2.2-5: VRB-to-PRB mapping

| Bit field mapped to index | VRB-to-PRB mapping |
|---------------------------|--------------------|
| 0                         | Non-interleaved    |
| 1                         | Interleaved        |

Table 7.3.1.2.2-6: Allowed entries for DCI format 1\_1 and DCI format 1\_2, configured by higher layer parameter *ul-AccessConfigListDCI-1-1* and *ul-AccessConfigListDCI-1-2*, respectively, in frequency range 1

| Entry index | Channel Access Type                                            | The CP extension Text index defined in Clause 5.3.1 of [4, TS 38.211] |
|-------------|----------------------------------------------------------------|-----------------------------------------------------------------------|
| 0           | Type2C-ULChannelAccess defined in [clause 4.2.1.2.3 in 37.213] | 0                                                                     |
| 1           | Type2C-ULChannelAccess defined in [clause 4.2.1.2.3 in 37.213] | 2                                                                     |
| 2           | Type2B-ULChannelAccess defined in [clause 4.2.1.2.2 in 37.213] | 0                                                                     |
| 3           | Type2B-ULChannelAccess defined in [clause 4.2.1.2.2 in 37.213] | 2                                                                     |
| 4           | Type2A-ULChannelAccess defined in [clause 4.2.1.2.1 in 37.213] | 0                                                                     |
| 5           | Type2A-ULChannelAccess defined in [clause 4.2.1.2.1 in 37.213] | 1                                                                     |
| 6           | Type2A-ULChannelAccess defined in [clause 4.2.1.2.1 in 37.213] | 3                                                                     |
| 7           | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 0                                                                     |
| 8           | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 1                                                                     |
| 9           | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 2                                                                     |
| 10          | Type1-ULChannelAccess defined in [clause 4.2.1.1 in 37.213]    | 3                                                                     |

Table 7.3.1.2.2-6A: Allowed entries for DCI format 1\_1 and DCI format 1\_2, configured by higher layer parameter *ul-AccessConfigListDCI-1-1* in frequency range 2-2

| Entry index | Channel Access Type                                     |
|-------------|---------------------------------------------------------|
| 0           | Type 1 channel access defined in clause 4.4.1 of 37.213 |
| 1           | Type 2 channel access defined in clause 4.4.2 of 37.213 |
| 2           | Type 3 channel access defined in clause 4.4.3 of 37.213 |

### 7.3.1.2.3 Format 1\_2

DCI format 1\_2 is used for the scheduling of PDSCH in one cell.

The following information is transmitted by means of the DCI format 1\_2 with CRC scrambled by C-RNTI or CS-RNTI or MCS-C-RNTI:

- Identifier for DCI formats – 1 bits
  - The value of this bit field is always set to 1, indicating a DL DCI format.
- Carrier indicator – 0, 1, 2 or 3 bits determined by higher layer parameter *carrierIndicatorSizeDCI-1-2*, as defined in Clause 10.1 of [5, TS38.213]. This field is reserved when this format is carried by PDCCH on the primary cell and the UE is configured for scheduling on the primary cell from an SCell, with the same number of bits as that in this format carried by PDCCH on the SCell for scheduling on the primary cell.
- Bandwidth part indicator – 0, 1 or 2 bits as determined by the number of DL BWPs  $n_{BWP,RRC}$  configured by higher layers, excluding the initial DL bandwidth part. The bitwidth for this field is determined as  $\lceil \log_2(n_{BWP}) \rceil$  bits, where

- $n_{BWP} = n_{BWP,RRC} + 1$  if  $n_{BWP,RRC} \leq 3$ , in which case the bandwidth part indicator is equivalent to the ascending order of the higher layer parameter *BWP-Id*;
- otherwise  $n_{BWP} = n_{BWP,RRC}$ , in which case the bandwidth part indicator is defined in Table 7.3.1.1.2-1;

If a UE does not support active BWP change via DCI, the UE ignores this bit field.

- Frequency domain resource assignment – number of bits determined by the following:
  - $N_{RBG}$  bits if only resource allocation type 0 is configured, where  $N_{RBG}$  is defined in Clause 5.1.2.2.1 of [6, TS 38.214];
  - $\lceil \log_2(N_{RBG,K2}(N_{RBG,K2} + 1)/2) \rceil$  bits if only resource allocation type 1 is configured, or  $\max(\lceil \log_2(N_{RBG,K2}(N_{RBG,K2} + 1)/2) \rceil, N_{RBG}) + 1$  bits if *resourceAllocationDCI-1-2-r16* is configured as 'dynamicSwitch', where  $N_{RBG,K2} = \lceil (N_{RB}^{DL,BWP} + (N_{DL,BWP}^{start} \bmod K2)) / K2 \rceil$ ,  $N_{RB}^{DL,BWP}$  is the size of the active DL bandwidth part,  $N_{DL,BWP}^{start}$  is defined as in clause 4.4.4.4 of [4, TS 38.211] and  $K2$  is determined by higher layer parameter *resourceAllocationType1GranularityDCI-1-2*. If the higher layer parameter *resourceAllocationType1GranularityDCI-1-2* is not configured,  $K2$  is equal to 1.
  - If *resourceAllocationDCI-1-2-r16* is configured as 'dynamicSwitch', the MSB bit is used to indicate resource allocation type 0 or resource allocation type 1, where the bit value of 0 indicates resource allocation type 0 and the bit value of 1 indicates resource allocation type 1.
  - For resource allocation type 0, the  $N_{RBG}$  LSBs provide the resource allocation as defined in Clause 5.1.2.2.1 of [6, TS 38.214].
  - For resource allocation type 1, the  $\lceil \log_2(N_{RBG,K2}(N_{RBG,K2} + 1)/2) \rceil$  LSBs provide the resource allocation as defined in Clause 5.1.2.2.2 of [6, TS 38.214]

If "Bandwidth part indicator" field indicates a bandwidth part other than the active bandwidth part and if *resourceAllocationDCI-1-2-r16* is configured as 'dynamicSwitch' for the indicated bandwidth part, the UE assumes resource allocation type 0 for the indicated bandwidth part if the bitwidth of the "Frequency domain resource assignment" field of the active bandwidth part is smaller than the bitwidth of the "Frequency domain resource assignment" field of the indicated bandwidth part.

- Time domain resource assignment – 0, 1, 2, 3, or 4 bits as defined in Clause 5.1.2.1 of [6, TS 38.214]. The bitwidth for this field is determined as  $\lceil \log_2(I) \rceil$  bits, where  $I$  is the number of entries in the higher layer parameter *pdsch-TimeDomainAllocationListDCI-1-2* if the higher layer parameter is configured, or  $I$  is the number of entries in the higher layer parameter *pdsch-TimeDomainAllocationList* if the higher layer parameter *pdsch-TimeDomainAllocationListDCI-1-2* is not configured; otherwise  $I$  is the number of entries in the default table.
- VRB-to-PRB mapping – 0 or 1 bit:
  - 0 bit if the higher layer parameter *vrB-ToPRB-InterleaverDCI-1-2* is not configured;
  - 1 bit according to Table 7.3.1.2.2-5 otherwise, only applicable to resource allocation type 1, as defined in Clause 7.3.1.6 of [4, TS 38.211].
- PRB bundling size indicator – 0 bit if the higher layer parameter *prb-BundlingTypeDCI-1-2* is not configured or is set to 'static', or 1 bit if the higher layer parameter *prb-BundlingTypeDCI-1-2* is set to 'dynamic' according to Clause 5.1.2.3 of [6, TS 38.214].
- Rate matching indicator – 0, 1, or 2 bits according to higher layer parameters *rateMatchPatternGroup1DCI-1-2* and *rateMatchPatternGroup2DCI-1-2*, where the MSB is used to indicate *rateMatchPatternGroup1DCI-1-2* and the LSB is used to indicate *rateMatchPatternGroup2DCI-1-2* when there are two groups.
- ZP CSI-RS trigger – 0, 1, or 2 bits as defined in Clause 5.1.4.2 of [6, TS 38.214]. The bitwidth for this field is determined as  $\lceil \log_2(n_{ZP} + 1) \rceil$  bits, where  $n_{ZP}$  is the number of aperiodic ZP CSI-RS resource sets configured by higher layer parameter *aperiodicZP-CSI-RS-ResourceSetsToAddModListDCI-1-2*.
- Modulation and coding scheme – 5 bits as defined in Clause 5.1.3.1 of [6, TS 38.214]
- New data indicator – 1 bit

- Redundancy version – 0, 1 or 2 bits determined by higher layer parameter *numberOfBitsForRV-DCI-1-2*
  - If 0 bit is configured,  $rv_{id}$  to be applied is 0;
  - 1 bit according to Table 7.3.1.2.3-1;
  - 2 bits according to Table 7.3.1.1.1-2.
- HARQ process number – number of bits determined by the following:
  - 0, 1, 2, 3, 4 or 5 bits determined by higher layer parameter *harq-ProcessNumberSizeDCI-1-2-v1700* if configured;
  - otherwise 0, 1, 2, 3 or 4 bits determined by higher layer parameter *harq-ProcessNumberSizeDCI-1-2*
- Downlink assignment index – 0, 1, 2 or 4 bits
  - 0 bit if the higher layer parameter *downlinkAssignmentIndexDCI-1-2* is not configured;
  - 1, 2 or 4 bits determined by higher layer parameter *downlinkAssignmentIndexDCI-1-2* otherwise,
    - 4 bits if more than one serving cell are configured in the DL and the higher layer parameter *pdsch-HARQ-ACK-Codebook=dynamic*, where the 2 MSB bits are the counter DAI and the 2 LSB bits are the total DAI
    - 4 bits if only one serving cell is configured in the DL and the higher layer parameter *pdsch-HARQ-ACK-Codebook=dynamic*, and the UE is not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with value 0 for one or more first CORESETs and is provided *coresetPoolIndex* with value 1 for one or more second CORESETs, and is provided *ackNackFeedbackMode = joint*, where the 2 MSB bits are the counter DAI and the 2 LSB bits are the total DAI.
    - 1 or 2 bits if only one serving cell is configured in the DL and the higher layer parameter *pdsch-HARQ-ACK-Codebook=dynamic*, when the UE is not configured with *coresetPoolIndex* or the value of *coresetPoolIndex* is the same for all CORESETs if *coresetPoolIndex* is provided or the UE is not configured with *ackNackFeedbackMode = joint*, where the 1 bit or 2 bits are the counter DAI.

If the UE is configured with a PUCCH-SCell, the number of serving cells is determined within a PUCCH group.

If the UE is configured with a PUCCH-SCell, *pdsch-HARQ-ACK-Codebook* is replaced by *pdsch-HARQ-ACK-Codebook-secondaryPUCCHgroup-r16* if present for the secondary PUCCH group.

If higher layer parameter *priorityIndicatorDCI-1-2* is configured, if the bit width of the Downlink assignment index in DCI format 1\_2 for one HARQ-ACK codebook is not equal to that of the Downlink assignment index in DCI format 1\_2 for the other HARQ-ACK codebook, a number of most significant bits with value set to '0' are inserted to smaller Downlink assignment index until the bit width of the Downlink assignment index in DCI format 1\_2 for the two HARQ-ACK codebooks are the same.

- TPC command for scheduled PUCCH – 2 bits as defined in Clause 7.2.1 of [5, TS 38.213]
- Second TPC command for scheduled PUCCH – 2 bits as defined in Clause 7.2.1 of [5, TS 38.213] if higher layer parameter *SecondTPCFieldDCI-1-2* is configured; 0 bit otherwise.
- PUCCH resource indicator – 0 or 1 or 2 or 3 bits determined by higher layer parameter *numberOfBitsForPUCCH-ResourceIndicatorDCI-1-2*

If higher layer parameter *pucch-sCellPattern* or *pucch-sCellDynDCI-1-2* is configured, if the bit width of the PUCCH resource indicator in DCI format 1\_2 associated with one cell for PUCCH transmission is not equal to that of the PUCCH resource indicator in DCI format 1\_2 associated with the other cell for PUCCH transmission, a number of most significant bits with value set to '0' are inserted to smaller PUCCH resource indicator until the bit width of the PUCCH resource indicator in DCI format 1\_2 associated with the two cells for PUCCH transmissions are the same.

If the UE is configured with a PUCCH-SCell, *pucch-sCellPattern* is replaced by *pucch-sCellPatternSecondaryPUCCHgroup* for the secondary PUCCH group.

- PDSCH-to-HARQ\_feedback timing indicator – 0, 1, 2, or 3 bits as defined in Clause 9.2.3 of [5, TS 38.213]. The bitwidth for this field is determined as  $\lceil \log_2(I) \rceil$  bits, where  $I$  is the number of entries in the higher layer parameter *DL-DataToUL-ACK-DCI-1-2*.

If higher layer parameter *priorityIndicatorDCI-1-2* is configured, if the bit width of the PDSCH-to-HARQ\_feedback timing indicator in DCI format 1\_2 for one HARQ-ACK codebook is not equal to that of the PDSCH-to-HARQ\_feedback timing indicator in DCI format 1\_2 for the other HARQ-ACK codebook on the same cell for PUCCH transmission, a number of most significant bits with value set to '0' are inserted to smaller PDSCH-to-HARQ\_feedback timing indicator until the bit width of the PDSCH-to-HARQ\_feedback timing indicator in DCI format 1\_2 for the two HARQ-ACK codebooks are the same.

If higher layer parameter *pucch-sCellDynDCI-1-2* is configured, if the bit width of the PDSCH-to-HARQ\_feedback timing indicator in DCI format 1\_2 associated with one cell for PUCCH transmission is not equal to that of the PDSCH-to-HARQ\_feedback timing indicator in DCI format 1\_2 associated with the other cell for PUCCH transmission, a number of most significant bits with value set to '0' are inserted to smaller PDSCH-to-HARQ\_feedback timing indicator until the bit width of the PDSCH-to-HARQ\_feedback timing indicator in DCI format 1\_2 associated with the two cells are the same.

- One-shot HARQ-ACK request – 0 or 1 bit.
  - 1 bit if higher layer parameter *pdsch-HARQ-ACK-OneShotFeedbackDCI-1-2* or *pdsch-HARQ-ACK-EnhType3DCI-1-2* is configured;
  - 0 bit otherwise.
- Enhanced Type 3 codebook indicator - 0, 1, 2, or 3 bits.
  - 0 bit if *pdsch-HARQ-ACK-EnhType3DCI-Field-1-2* is not configured;
  - $\lceil \log_2(n_{CB}) \rceil$  bits otherwise, where  $n_{CB}$  is the number of entries in the higher layer parameter *pdsch-HARQ-ACK-EnhType3ToAddModList*.

If the UE is configured with a PUCCH-SCell, *pdsch-HARQ-ACK-EnhType3ToAddModList* is replaced by *pdsch-HARQ-ACK-EnhType3SecondaryToAddModList* for the secondary PUCCH group.

- HARQ-ACK retransmission indicator – 0 or 1 bit.
  - 1 bit if higher layer parameter *pdsch-HARQ-ACK-retxDCI-1-2* is configured.
  - 0 bit otherwise.
- Antenna port(s) – 0, 4, 5, or 6 bits
  - 0 bit if higher layer parameter *antennaPortsFieldPresenceDCI-1-2* is not configured;
  - Otherwise 4, 5 or 6 bits as defined by Tables 7.3.1.2.2-1/2/3/4 and Tables 7.3.1.2.2-1A/2A/3A/4A, where the number of CDM groups without data of values 1, 2, and 3 refers to CDM groups {0}, {0,1}, and {0, 1,2} respectively. The antenna ports  $\{p_0, \dots, p_{v-1}\}$  shall be determined according to the ordering of DMRS port(s) given by Tables 7.3.1.2.2-1/2/3/4 or Tables 7.3.1.2.2-1A/2A/3A/4A. When a UE receives an activation command that maps at least one codepoint of DCI field 'Transmission Configuration Indication' to two TCI states, the UE shall use Table 7.3.1.2.2-1A/2A/3A/4A; otherwise, it shall use Tables 7.3.1.2.2-1/2/3/4.
  - If a UE is configured with both *dmrs-DownlinkForPDSCH-MappingTypeA-DCI-1-2* and *dmrs-DownlinkForPDSCH-MappingTypeB-DCI-1-2* and is configured with higher layer parameter *antennaPortsFieldPresenceDCI-1-2*, the bitwidth of this field equals  $\max\{x_A, x_B\}$ , where  $x_A$  is the "Antenna ports" bitwidth derived according to *dmrs-DownlinkForPDSCH-MappingTypeA-DCI-1-2* and  $x_B$  is the "Antenna ports" bitwidth derived according to *dmrs-DownlinkForPDSCH-MappingTypeB-DCI-1-2*. A number of  $|x_A - x_B|$  zeros are padded in the MSB of this field, if the mapping type of the PDSCH corresponds to the smaller value of  $x_A$  and  $x_B$ .

If a UE is not configured with higher layer parameter *antennaPortsFieldPresenceDCI-1-2*, antenna port(s) are defined assuming bit field index value 0 in Tables 7.3.1.2.2-1/2/3/4.



- Transmission configuration indication – 0 bit if higher layer parameter *tci-PresentDCI-1-2* is not configured; otherwise 1 or 2 or 3 bits determined by higher layer parameter *tci-PresentDCI-1-2* as defined in Clause 5.1.5 of [6, TS38.214].

If "Bandwidth part indicator" field indicates a bandwidth part other than the active bandwidth part,

- if the higher layer parameter *tci-PresentDCI-1-2* is not configured for the CORESET used for the PDCCH carrying the DCI format 1\_2,
  - the UE assumes *tci-PresentDCI-1-2* is not configured for all CORESETs in the indicated bandwidth part;
- otherwise,
  - the UE assumes *tci-PresentDCI-1-2* is configured for all CORESETs in the indicated bandwidth part with the same value configured for the CORESET used for the PDCCH carrying the DCI format 1\_2.
- SRS request – 0, 1, 2 or 3 bits
  - 0 bit if the higher layer parameter *srs-RequestDCI-1-2* is not configured;
  - 1 bit as defined by Table 7.3.1.1.3-1 if the higher layer parameter *srs-RequestDCI-1-2* = 1 and for UEs not configured with *supplementaryUplink* in *ServingCellConfig* in the cell;
  - 2 bits if the higher layer parameter *srs-RequestDCI-1-2* = 1 and for UEs configured with *supplementaryUplink* in *ServingCellConfig* in the cell, where the first bit is the non-SUL/SUL indicator as defined in Table 7.3.1.1.1-1 and the second bit is defined by Table 7.3.1.1.3-1;
  - 2 bits as defined by Table 7.3.1.1.2-24 if the higher layer parameter *srs-RequestDCI-1-2* = 2 and for UEs not configured with *supplementaryUplink* in *ServingCellConfig* in the cell;
  - 3 bits if the higher layer parameter *srs-RequestDCI-1-2* = 2 and for UEs configured with *supplementaryUplink* in *ServingCellConfig* in the cell, where the first bit is the non-SUL/SUL indicator as defined in Table 7.3.1.1.1-1 and the second and third bits are defined by Table 7.3.1.1.2-24;
- SRS offset indicator – 0, 1 or 2 bits.
  - 0 bit if higher layer parameter *AvailableSlotOffset* is not configured for any aperiodic SRS resource set in the scheduled cell, or if higher layer parameter *AvailableSlotOffset* is configured for at least one aperiodic SRS resource set in the scheduled cell and the maximum number of entries of *availableSlotOffsetList* configured for all aperiodic SRS resource set(s) is 1;
  - otherwise,  $\lceil \log_2(K) \rceil$  bits are used to indicate available slot offset according to Table 7.3.1.1.2-37 and Clause 6.2.1 of [6, TS 38.214], where K is the maximum number of entries of *availableSlotOffsetList* configured for all aperiodic SRS resource set(s) in the scheduled cell;
- DMRS sequence initialization – 0 or 1 bit
  - 0 bit if the higher layer parameter *dmrs-SequenceInitializationDCI-1-2* is not configured;
  - 1 bit otherwise.
- Priority indicator – 0 bit if higher layer parameter *priorityIndicatorDCI-1-2* is not configured; otherwise 1 bit as defined in Clause 9 in [5, TS 38.213].
- PDCCH monitoring adaptation indication – 0, 1 or 2 bits
  - 1 or 2 bits, if *searchSpaceGroupIdList-r17* is not configured and if *pdccch-SkippingDurationList* is configured
    - 1 bit if the UE is configured with only one duration by *pdccch-SkippingDurationList*;
    - 2 bits if the UE is configured with more than one duration by *pdccch-SkippingDurationList*.
  - 1 or 2 bits, if *pdccch-SkippingDurationList* is not configured and if *searchSpaceGroupIdList-r17* is configured

- 1 bit if the UE is configured by *searchSpaceGroupIdList-r17* with search space set(s) with group index 0 and search space set(s) with group index 1, and if the UE is not configured by *searchSpaceGroupIdList-r17* with any search space set with group index 2;
- 2 bits if the UE is configured by *searchSpaceGroupIdList-r17* with search space set(s) with group index 0, search space set(s) with group index 1 and search space set(s) with group index 2;
- 2 bits, if *pdccch-SkippingDurationList* is configured and if *searchSpaceGroupIdList-r17* is configured
- 0 bit, otherwise
- ChannelAccess-CPext – 0, 1, 2, 3 or 4 bits. The bitwidth for this field is determined as  $\lceil \log_2(I) \rceil$  bits, where  $I$  is the number of entries in the higher layer parameter *ul-AccessConfigListDCI-1-2* or in Table 7.3.1.1.1-4A if *channelAccessMode-r16* = "semiStatic" is provided, for operation in a cell with shared spectrum channel access in frequency range 1, or the number of entries in the high layer parameter *ul-AccessConfigListDCI-1-1* for operation in frequency range 2-2 if *ChannelAccessMode2-r17* is provided; otherwise 0 bit. One or more entries from Table 7.3.1.2.2-6 are configured by the higher layer parameter *ul-AccessConfigListDCI-1-2* in frequency range 1. One or more entries from Table 7.3.1.1.2-6A are configured by the higher layer parameter *ul-AccessConfigListDCI-1-1* in frequency range 2-2.
- PUCCH Cell indicator – 0 or 1 bit.
  - 1 bit if higher layer parameter *pucch-sSCellDynDCI-1-2* is configured.
  - 0 bit otherwise.

If DCI formats 1\_2 are monitored in multiple search spaces associated with multiple CORESETs in a BWP for scheduling the same serving cell, zeros shall be appended until the payload size of the DCI formats 1\_2 monitored in the multiple search spaces equal to the maximum payload size of the DCI format 1\_2 monitored in the multiple search spaces.

For a UE configured with scheduling on the primary cell from an SCell, if prior to padding the number of information bits in DCI format 1\_2 carried by PDCCH on the primary cell is not equal to the number of information bits in DCI format 1\_2 carried by PDCCH on the SCell for scheduling on the primary cell, zeros shall be appended to the DCI format 1\_2 with smaller size until the payload size is the same.

- If application of step 4B in clause 7.3.1.0 results in additional zero padding for DCI format 1\_2 for scheduling on the primary cell, corresponding zeros shall be appended to both DCI format 1\_2 monitored on the primary cell and DCI format 1\_2 monitored on the SCell for scheduling on the primary cell.
- If the SCell is deactivated and *firstActiveDownlinkBWP-Id* is not set to dormant BWP, the UE determines the number of information bits in DCI format 1\_2 carried by PDCCH on the primary cell based on a DL BWP provided by *firstActiveDownlinkBWP-Id* for the SCell. If the active DL BWP of the SCell is a dormant DL BWP, or if the SCell is deactivated and *firstActiveDownlinkBWP-Id* is set to dormant BWP, the UE determines the number of information bits in DCI format 1\_2 carried by PDCCH on the primary cell based on a DL BWP provided by *firstWithinActiveTimeBWP-Id* for the SCell if provided; otherwise, based on a DL BWP provided by *firstOutsideActiveTimeBWP-Id* for the SCell.

**Table 7.3.1.2.3-1: Redundancy version**

| Value of the Redundancy version field | Value of $rv_{id}$ to be applied |
|---------------------------------------|----------------------------------|
| 0                                     | 0                                |
| 1                                     | 3                                |

### 7.3.1.3 DCI formats for other purposes

#### 7.3.1.3.1 Format 2\_0

DCI format 2\_0 is used for notifying the slot format, COT duration, available RB set, and search space set group switching.

The following information is transmitted by means of the DCI format 2\_0 with CRC scrambled by SFI-RNTI:

- If the higher layer parameter *slotFormatCombToAddModList* is configured,
  - Slot format indicator 1, Slot format indicator 2, ..., Slot format indicator *N*,
- If the higher layer parameter *availableRB-SetsToAddModList* is configured,
  - Available RB set Indicator 1, Available RB set Indicator 2, ..., Available RB set Indicator *N1*,
- If the higher layer parameter *co-DurationsPerCellToAddModList* is configured
  - COT duration indicator 1, COT duration indicator 2, ..., COT duration indicator *N2*.
- If the higher layer parameter *switchTriggerToAddModList* is configured
  - Search space set group switching flag 1, Search space set group switching flag 2, ..., Search space set group switching flag *M*.

The size of DCI format 2\_0 is configurable by higher layers up to 128 bits, according to Clause 11.1.1 of [5, TS 38.213].

#### 7.3.1.3.2 Format 2\_1

DCI format 2\_1 is used for notifying the PRB(s) and OFDM symbol(s) where UE may assume no transmission is intended for the UE.

The following information is transmitted by means of the DCI format 2\_1 with CRC scrambled by INT-RNTI:

- Pre-emption indication 1, Pre-emption indication 2, ..., Pre-emption indication *N*.

The size of DCI format 2\_1 is configurable by higher layers up to 126 bits, according to Clause 11.2 of [5, TS 38.213]. Each pre-emption indication is 14 bits.

#### 7.3.1.3.3 Format 2\_2

DCI format 2\_2 is used for the transmission of TPC commands for PUCCH and PUSCH.

The following information is transmitted by means of the DCI format 2\_2 with CRC scrambled by TPC-PUSCH-RNTI or TPC-PUCCH-RNTI:

- block number 1, block number 2,..., block number *N*

The parameter *tpc-PUSCH* or *tpc-PUCCH* provided by higher layers determines the index to the block number for an UL of a cell, with the following fields defined for each block:

- Closed loop indicator – 0 or 1 bit.
- For DCI format 2\_2 with TPC-PUSCH-RNTI, 0 bit if the UE is not configured with high layer parameter *twoPUSCH-PC-AdjustmentStates*, in which case UE assumes each block in the DCI format 2\_2 is of 2 bits; 1 bit otherwise, in which case UE assumes each block in the DCI format 2\_2 is of 3 bits;
- For DCI format 2\_2 with TPC-PUCCH-RNTI, 0 bit if the UE is not configured with high layer parameter *twoPUCCH-PC-AdjustmentStates*, in which case UE assumes each block in the DCI format 2\_2 is of 2 bits; 1 bit otherwise, in which case UE assumes each block in the DCI format 2\_2 is of 3 bits;
- TPC command – 2 bits

The number of information bits in format 2\_2 shall be equal to or less than the payload size of format 1\_0 monitored in common search space in the same serving cell. If the number of information bits in format 2\_2 is less than the payload size of format 1\_0 monitored in common search space in the same serving cell, zeros shall be appended to format 2\_2 until the payload size equals that of format 1\_0 monitored in common search space in the same serving cell.

#### 7.3.1.3.4 Format 2\_3

DCI format 2\_3 is used for the transmission of a group of TPC commands for SRS transmissions by one or more UEs. Along with a TPC command, a SRS request may also be transmitted.

The following information is transmitted by means of the DCI format 2\_3 with CRC scrambled by TPC-SRS-RNTI:

- block number 1, block number 2, ..., block number  $B$

where the starting position of a block is determined by the parameter *startingBitOfFormat2-3* or *startingBitOfFormat2-3SUL-v1530* provided by higher layers for the UE configured with the block.

If the UE is configured with higher layer parameter *srs-TPC-PDCCH-Group* = *typeA* for an UL without PUCCH and PUSCH or an UL on which the SRS power control is not tied with PUSCH power control, one or two blocks are configured for the UE by higher layers where one block applies to non-SUL carriers and another block applies to SUL carriers, with the following fields defined for each block:

- SRS request – 0 or 2 bits. The presence of this field is according to the definition in Clause 11.4 of [5, TS38.213]. If present, this field is interpreted as defined by Table 7.3.1.1.2-24.
- TPC command number 1, TPC command number 2, ..., TPC command number  $N$ , where each TPC command applies to a respective UL carrier provided by higher layer parameter *cc-IndexInOneCC-Set*

If the UE is configured with higher layer parameter *srs-TPC-PDCCH-Group* = *typeB* for an UL without PUCCH and PUSCH or an UL on which the SRS power control is not tied with PUSCH power control, one block or more blocks is configured for the UE by higher layers where each block applies to an UL carrier, with the following fields defined for each block:

- SRS request – 0 or 2 bits. The presence of this field is according to the definition in Clause 11.4 of [5, TS38.213]. If present, this field is interpreted as defined by Table 7.3.1.1.2-24.
- TPC command – 2 bits

The number of information bits in format 2\_3 shall be equal to or less than the payload size of format 1\_0 monitored in common search space in the same serving cell. If the number of information bits in format 2\_3 is less than the payload size of format 1\_0 monitored in common search space in the same serving cell, zeros shall be appended to format 2\_3 until the payload size equals that of format 1\_0 monitored in common search space in the same serving cell.

#### 7.3.1.3.5 Format 2\_4

DCI format 2\_4 is used for notifying the PRB(s) and OFDM symbol(s) where UE cancels the corresponding UL transmission from the UE according to Clause 11.2A of [5, TS 38.213].

The following information is transmitted by means of the DCI format 2\_4 with CRC scrambled by CI-RNTI:

- Cancellation indication 1, Cancellation indication 2, ..., Cancellation indication indication  $N$ .

The size of DCI format 2\_4 is configurable by higher layers parameter *dci-PayloadSizeForCI* up to 126 bits, according to Clause 11.2A of [5, TS 38.213]. The number of bits for each cancellation indication is configurable by higher layer parameter *ci-PayloadSize*. For a UE, there is at most one cancellation indication for an UL carrier.

#### 7.3.1.3.6 Format 2\_5

DCI format 2\_5 is used for notifying the availability of soft resources as defined in Clause 9.3.1 of [10, TS 38.473]

The following information is transmitted by means of the DCI format 2\_5 with CRC scrambled by AI-RNTI:

- Availability indicator 1, Availability indicator 2, ..., Availability indicator  $N$ .

The size of DCI format 2\_5 is configurable by higher layers up to 128 bits, according to Clause 14 of [5, TS 38.213].

#### 7.3.1.3.7 Format 2\_6

DCI format 2\_6 is used for notifying the power saving information outside DRX Active Time for one or more UEs.

The following information is transmitted by means of the DCI format 2\_6 with CRC scrambled by PS-RNTI:

- block number 1, block number 2,..., block number  $N$

where the starting position of a block is determined by the parameter *ps-PositionDCI-2-6* provided by higher layers for the UE configured with the block.

If the UE is configured with higher layer parameter *ps-RNTI* and *dci-Format2-6*, one block is configured for the UE by higher layers, with the following fields defined for the block:

- Wake-up indication - 1 bit
- SCell dormancy indication – 0 bit if higher layer parameter *dormancyGroupOutsideActiveTime* is not configured; otherwise 1, 2, 3, 4 or 5 bits bitmap determined according to the number of different *DormancyGroupID(s)* provided by higher layer parameter *dormancyGroupOutsideActiveTime*, where each bit corresponds to one of the SCell group(s) configured by higher layers parameter *dormancyGroupOutsideActiveTime*, with MSB to LSB of the bitmap corresponding to the first to last configured SCell group in ascending order of *DormancyGroupID*.

The size of DCI format 2\_6 is indicated by the higher layer parameter *sizeDCI-2-6*, according to Clause 10.3 of [5, TS 38.213].

#### 7.3.1.3.8 Format 2\_7

DCI format 2\_7 is used for notifying the paging early indication and TRS availability indication for one or more UEs.

The following information is transmitted by means of the DCI format 2\_7 with CRC scrambled by PEI-RNTI:

- Paging indication field –  $N_{PO}^{PEI} N_{SG}^{PO}$  bit(s), where
  - $N_{PO}^{PEI}$  is the number of paging occasions configured by higher layer parameter *po-NumPerPEI* as defined in Clause 10.4A in [5, TS 38.213];
  - $N_{SG}^{PO}$  is the number of sub-groups of a paging occasion configured by higher layer parameter *subgroupsNumPerPO*.
- Each bit in the field indicates one UE subgroup of a paging occasion.
- TRS availability indication – 1, 2, 3, 4, 5, or 6 bits, where the number of bits is equal to one plus the highest value of all the *indBitID(s)* provided by the *trs-ResourceSetConfig* if configured; 0 bits otherwise.

The size of DCI format 2\_7 is indicated by the higher layer parameter *payloadSizeDCI-2-7*, according to Clause 10.4A of [5, TS 38.213]. The number of information bits in format 2\_7 shall be equal to or less than the payload size of format 2\_7. If the number of information bits in format 2\_7 is less than the size of format 2\_7, the remaining bits are reserved.

#### 7.3.1.4 DCI formats for scheduling of sidelink

##### 7.3.1.4.1 Format 3\_0

DCI format 3\_0 is used for scheduling of NR PSCCH and NR PSSCH in one cell.

The following information is transmitted by means of the DCI format 3\_0 with CRC scrambled by SL-RNTI or SL-CS-RNTI:

- Resource pool index –  $\lceil \log_2 I \rceil$  bits, where  $I$  is the total number of resource pools for transmission configured by the higher layer parameter *sl-TxPoolScheduling*, if configured, and *sl-DiscTxPoolScheduling*, if configured.
- Time gap – 3 bits determined by higher layer parameter *sl-DCI-ToSL-Trans*, as defined in clause 8.1.2.1 of [6, TS 38.214]
- HARQ process number – 4 bits.
- New data indicator – 1 bit.

- Lowest index of the subchannel allocation to the initial transmission –  $\lceil \log_2(N_{\text{subChannel}}^{\text{SL}}) \rceil$  bits as defined in clause 8.1.2.2 of [6, TS 38.214]
- SCI format 1-A fields according to clause 8.3.1.1:
  - Frequency resource assignment.
  - Time resource assignment.
- PSFCH-to-HARQ feedback timing indicator –  $\lceil \log_2 N_{\text{fb\_timing}} \rceil$  bits, where  $N_{\text{fb\_timing}}$  is the number of entries in the higher layer parameter *sl-PSFCH-ToPUCCH*, as defined in clause 16.5 of [5, TS 38.213]
- PUCCH resource indicator – 3 bits as defined in clause 16.5 of [5, TS 38.213].
- Configuration index – 0 bit if the UE is not configured to monitor DCI format 3\_0 with CRC scrambled by SL-CS-RNTI; otherwise 3 bits as defined in clause 8.1.2 of [6, TS 38.214]. If the UE is configured to monitor DCI format 3\_0 with CRC scrambled by SL-CS-RNTI, this field is reserved for DCI format 3\_0 with CRC scrambled by SL-RNTI.
- Counter sidelink assignment index – 2 bits
  - 2 bits as defined in clause 16.5.2 of [5, TS 38.213] if the UE is configured with *pdsch-HARQ-ACK-Codebook = dynamic*
  - 2 bits as defined in clause 16.5.1 of [5, TS 38.213] if the UE is configured with *pdsch-HARQ-ACK-Codebook = semi-static*
- Padding bits, if required

If the total number of transmit resource pools provided in *sl-TxPoolScheduling*, if configured, and *sl-DiscTxPoolScheduling*, if configured, is larger than one, zeros shall be appended to the DCI format 3\_0 until the payload size is equal to the size of a DCI format 3\_0 given by a configuration of the transmit resource pool resulting in the largest number of information bits for DCI format 3\_0.

If the UE is configured to monitor DCI format 3\_1 and the number of information bits in DCI format 3\_0 is less than the payload of DCI format 3\_1, zeros shall be appended to DCI format 3\_0 until the payload size equals that of DCI format 3\_1.

#### 7.3.1.4.2 Format 3\_1

DCI format 3\_1 is used for scheduling of LTE PSCCH and LTE PSSCH in one cell.

The following information is transmitted by means of the DCI format 3\_1 with CRC scrambled by SL Semi-Persistent Scheduling V-RNTI:

- Timing offset – 3 bits determined by higher layer parameter *sl-TimeOffsetEUTRA-List*, as defined in clause 16.6 of [5, TS 38.213]
- Carrier indicator – 3 bits as defined in 5.3.3.1.9A of [11, TS 36.212].
- Lowest index of the subchannel allocation to the initial transmission –  $\lceil \log_2(N_{\text{subchannel}}^{\text{SL}}) \rceil$  bits as defined in 5.3.3.1.9A of [11, TS 36.212].
- Frequency resource location of initial transmission and retransmission, as defined in 5.3.3.1.9A of [11, TS 36.212]
- Time gap between initial transmission and retransmission, as defined in 5.3.3.1.9A of [11, TS 36.212]
- SL index – 2 bits as defined in 5.3.3.1.9A of [11, TS 36.212]
- SL SPS configuration index – 3 bits as defined in clause 5.3.3.1.9A of [11, TS 36.212].
- Activation/release indication – 1 bit as defined in clause 5.3.3.1.9A of [11, TS 36.212].

If the UE is configured to monitor DCI format 3\_0 and the number of information bits in DCI format 3\_1 is less than the payload of DCI format 3\_0, zeros shall be appended to DCI format 3\_1 until the payload size equals that of DCI format 3\_0.

### 7.3.1.5 DCI formats for scheduling of MBS

#### 7.3.1.5.1 Format 4\_0

DCI format 4\_0 is used for the scheduling of PDSCH for broadcast in DL cell.

The following information is transmitted by means of the DCI format 4\_0 with CRC scrambled by MCCH-RNTI or G-RNTI for broadcast configured by *MBS-SessionInfo*:

- Frequency domain resource assignment –  $\lceil \log_2(N_{RB}^{DL,CFR}(N_{RB}^{DL,CFR} + 1)/2) \rceil$  bits where  $N_{RB}^{DL,CFR}$  equals to
  - the size of CORESET 0 if CORESET 0 is configured for the cell; and
  - the size of initial DL bandwidth part if CORESET 0 is not configured for the cell.
- Time domain resource assignment – 4 bits as defined in Clause 5.1.2.1 of [6, TS38.214]
- VRB-to-PRB mapping – 1 bit according to Table 7.3.1.2.2-5
- Modulation and coding scheme – 5 bits as defined in Clause 5.1.3 of [6, TS38.214]
- Redundancy version – 2 bits as defined in Table 7.3.1.1.1-2
- MCCH change notification – 2 bits as defined in Clause 5.9.1.3 of [9, TS38.331] if the CRC of the DCI format 4\_0 is scrambled by MCCH-RNTI. Otherwise, this bit field is reserved.
- Reserved bits – 14bits

#### 7.3.1.5.2 Format 4\_1

DCI format 4\_1 is used for the scheduling of PDSCH for multicast in DL cell.

The following information is transmitted by means of the DCI format 4\_1 with CRC scrambled by G-RNTI for multicast or G-CS-RNTI configured by *MBS-RNTI-SpecificConfig*:

- Frequency domain resource assignment –  $\lceil \log_2(N_{RB}^{DL,CFR}(N_{RB}^{DL,CFR} + 1)/2) \rceil$  bits where  $N_{RB}^{DL,CFR}$  equals to
  - the size of CORESET 0 if CORESET 0 is configured for the cell; and
  - the size of initial DL bandwidth part if CORESET 0 is not configured for the cell.
- Time domain resource assignment – 4 bits as defined in Clause 5.1.2.1 of [6, TS38.214]
- VRB-to-PRB mapping – 1 bit according to Table 7.3.1.2.2-5
- Modulation and coding scheme – 5 bits as defined in Clause 5.1.3 of [6, TS38.214]
- New data indicator – 1 bit
- Redundancy version – 2 bits as defined in Table 7.3.1.1.1-2
- HARQ process number – 4 bits
- Downlink assignment index – 2 bits as defined in Clause 9.1.3 of [5, TS 38.213], as counter DAI
- PUCCH resource indicator – 3 bits as defined in Clause 9.2.3 of [5, TS38.213]
- PDSCH-to-HARQ\_feedback timing indicator – 3 bits as defined in Clause 9.2.3 of [5, TS38.213]
- Reserved bits – 3 bits

### 7.3.1.5.3 Format 4\_2

DCI format 4\_2 is used for the scheduling of PDSCH for multicast in DL cell.

The following information is transmitted by means of the DCI format 4\_2 with CRC scrambled by G-RNTI for multicast or G-CS-RNTI configured by *MBS-RNTI-SpecificConfig*:

- Frequency domain resource assignment – number of bits determined by the following, where  $N_{RB}^{DL,CFR}$  is the size of the common frequency resource as defined in Clause 18 of [5, TS38.213].
  - $N_{RBG}$  bits if only resource allocation type 0 is configured, where  $N_{RBG}$  is defined in Clause 5.1.2.2.1 of [6, TS38.214],
  - $\lceil \log_2(N_{RB}^{DL,CFR}(N_{RB}^{DL,CFR} + 1)/2) \rceil$  bits if only resource allocation type 1 is configured, or
  - $\max(\lceil \log_2(N_{RB}^{DL,CFR}(N_{RB}^{DL,CFR} + 1)/2) \rceil, N_{RBG}) + 1$  bits if *resourceAllocation* in *pdsch-ConfigMulticast* is configured as 'dynamicSwitch'.
  - If *resourceAllocation* in *pdsch-ConfigMulticast* is configured as 'dynamicSwitch', the MSB bit is used to indicate resource allocation type 0 or resource allocation type 1, where the bit value of 0 indicates resource allocation type 0 and the bit value of 1 indicates resource allocation type 1.
  - For resource allocation type 0, the  $N_{RBG}$  LSBs provide the resource allocation as defined in Clause 5.1.2.2.1 of [6, TS 38.214].
  - For resource allocation type 1, the  $\lceil \log_2(N_{RB}^{DL,CFR}(N_{RB}^{DL,CFR} + 1)/2) \rceil$  LSBs provide the resource allocation as defined in Clause 5.1.2.2.2 of [6, TS 38.214]
- Time domain resource assignment – 0, 1, 2, 3, or 4 bits as defined in Clause 5.1.2.1 of [6, TS 38.214]. The bitwidth for this field is determined as  $\lceil \log_2(I) \rceil$  bits, where  $I$  is the number of entries in the higher layer parameter *pdsch-TimeDomainAllocationList* if the higher layer parameter is configured; otherwise  $I$  is the number of entries in the default table.
- VRB-to-PRB mapping – 0 or 1 bit:
  - 0 bit if only resource allocation type 0 is configured or if *vrb-ToPRB-Interleaver* in *pdsch-ConfigMulticast* is not configured;
  - 1 bit according to Table 7.3.1.2.2-5 otherwise, only applicable to resource allocation type 1, as defined in Clause 7.3.1.6 of [4, TS 38.211].
- PRB bundling size indicator – 0 bit if the higher layer parameter *prb-BundlingType* is not configured in *pdsch-ConfigMulticast* or is set to 'staticBundling', or 1 bit if the higher layer parameter *prb-BundlingType* in *pdsch-ConfigMulticast* is set to 'dynamicBundling' according to Clause 5.1.2.3 of [6, TS 38.214].
- Rate matching indicator – 0, 1, or 2 bits according to higher layer parameters *rateMatchPatternGroup1* and *rateMatchPatternGroup2* in *pdsch-ConfigMulticast*, where the MSB is used to indicate *rateMatchPatternGroup1* and the LSB is used to indicate *rateMatchPatternGroup2* when there are two groups.
- ZP CSI-RS trigger – 0, 1, or 2 bits as defined in Clause 5.1.4.2 of [6, TS 38.214]. The bitwidth for this field is determined as  $\lceil \log_2(n_{ZP} + 1) \rceil$  bits, where  $n_{ZP}$  is the number of aperiodic ZP CSI-RS resource sets configured in *pdsch-ConfigMulticast*.

For transport block 1:

- Modulation and coding scheme – 5 bits as defined in Clause 5.1.3.1 of [6, TS 38.214]
- New data indicator – 1 bit
- Redundancy version – 2 bits as defined in Table 7.3.1.1.1-2

For transport block 2 (only present if *maxNrofCodeWordsScheduledByDCI* configured in *pdsch-ConfigMulticast* equals 2):

- Modulation and coding scheme – 5 bits as defined in Clause 5.1.3.1 of [6, TS 38.214]



- New data indicator – 1 bit
- Redundancy version – 2 bits as defined in Table 7.3.1.1.1-2
- HARQ process number – 4 bits
- Downlink assignment index – number of bits as defined in the following
  - 2 bits if the higher layer parameter *pdsch-HARQ-ACK-Codebook* = *dynamic* is configured for multicast, where the 2 bits are the counter DAI;
  - 0 bits otherwise.

If higher layer parameter *priorityIndicatorDCI-4-2* is configured in *pdsch-ConfigMulticast*, if the bit width of the Downlink assignment index in DCI format 4\_2 for one HARQ-ACK codebook is not equal to that of the Downlink assignment index in DCI format 4\_2 for the other HARQ-ACK codebook, a number of most significant bits with value set to '0' are inserted to smaller Downlink assignment index until the bit width of the Downlink assignment index in DCI format 4\_2 for the two HARQ-ACK codebooks are the same.

- PUCCH resource indicator – 3 bits as defined in Clause 9.2.3 of [5, TS 38.213]
- PDSCH-to-HARQ\_feedback timing indicator – 0, 1, 2, or 3 bits as defined in Clause 9.2.3 of [5, TS 38.213]. The bitwidth for this field is determined as  $\lceil \log_2(I) \rceil$  bits, where  $I$  is the number of entries in the higher layer parameter *dl-DataToUL-ACK* in *pucch-ConfigMulticast1* if configured or *pucch-ConfigMulticast2* if configured; otherwise,  $I$  is the number of entries in the higher layer parameter *dl-DataToUL-ACK* in *PUCCH-Config*.

If higher layer parameter *priorityIndicatorDCI-4-2* is configured in *pdsch-ConfigMulticast*, if the bit width of the PDSCH-to-HARQ\_feedback timing indicator in DCI format 4\_2 for one HARQ-ACK codebook is not equal to that of the PDSCH-to-HARQ\_feedback timing indicator in DCI format 4\_2 for the other HARQ-ACK codebook, a number of most significant bits with value set to '0' are inserted to smaller PDSCH-to-HARQ\_feedback timing indicator until the bit width of the PDSCH-to-HARQ\_feedback timing indicator in DCI format 4\_2 for the two HARQ-ACK codebooks are the same.

- Antenna port(s) – 4, 5, or 6 bits as defined by Tables 7.3.1.2.2-1/2/3/4, where the number of CDM groups without data of values 1, 2, and 3 refers to CDM groups {0}, {0,1}, and {0, 1,2} respectively. The antenna ports  $\{p_0, \dots, p_{v-1}\}$  shall be determined according to the ordering of DMRS port(s) given by Tables 7.3.1.2.2-1/2/3/4.

If a UE is configured with both *dmrs-DownlinkForPDSCH-MappingTypeA* and *dmrs-DownlinkForPDSCH-MappingTypeB*, the bitwidth of this field equals  $\max\{x_A, x_B\}$ , where  $x_A$  is the "Antenna ports" bitwidth derived according to *dmrs-DownlinkForPDSCH-MappingTypeA* and  $x_B$  is the "Antenna ports" bitwidth derived according to *dmrs-DownlinkForPDSCH-MappingTypeB*. A number of  $|x_A - x_B|$  zeros are padded in the MSB of this field, if the mapping type of the PDSCH corresponds to the smaller value of  $x_A$  and  $x_B$ .

- Transmission configuration indication – 0 bit if higher layer parameter *tci-PresentInDCI* in *pdccch-ConfigMulticast* is not enabled; otherwise 3 bits as defined in Clause 5.1.5 of [6, TS38.214].
- DMRS sequence initialization – 1 bit.
- Priority indicator – 0 bit if higher layer parameter *priorityIndicatorDCI-4-2* is not configured in *pdsch-ConfigMulticast*; otherwise 1 bit as defined in Clause 9 in [5, TS 38.213].
- Enabling/disabling HARQ-ACK feedback indication – 1 bit if higher layer parameter *harq-FeedbackEnablerMulticast* indicates *dci-enabler*, where value 1 indicates enabling HARQ-ACK feedback and value 0 indicates disabling HARQ-ACK feedback; 0 bit, otherwise.

The size of DCI format 4\_2 is configurable by higher layer parameter *sizeDCI-4-2* from 20 bits and up to 140 bits. If the number of information bits in DCI format 4\_2 is less than the size of DCI format 4\_2, the remaining bits are reserved.

## 7.3.2 CRC attachment

Error detection is provided on DCI transmissions through a Cyclic Redundancy Check (CRC).

The entire payload is used to calculate the CRC parity bits. Denote the bits of the payload by  $a_0, a_1, a_2, a_3, \dots, a_{A-1}$ , and the parity bits by  $p_0, p_1, p_2, p_3, \dots, p_{L-1}$ , where  $A$  is the payload size and  $L$  is the number of parity bits. Let

$a'_0, a'_1, a'_2, a'_3, \dots, a'_{A+L-1}$  be a bit sequence such that  $a'_i = 1$  for  $i = 0, 1, \dots, L-1$  and  $a'_i = a_{i-L}$  for  $i = L, L+1, \dots, A+L-1$ . The parity bits are computed with input bit sequence  $a'_0, a'_1, a'_2, a'_3, \dots, a'_{A+L-1}$  and attached according to Clause 5.1 by setting  $L$  to 24 bits and using the generator polynomial  $g_{\text{CRC24C}}(D)$ . The output bit  $b_0, b_1, b_2, b_3, \dots, b_{K-1}$  is

$$b_k = a_k \quad \text{for } k = 0, 1, 2, \dots, A-1$$

$$b_k = p_{k-A} \quad \text{for } k = A, A+1, A+2, \dots, A+L-1,$$

where  $K = A + L$ .

After attachment, the CRC parity bits are scrambled with the corresponding RNTI  $x_{\text{rnti},0}, x_{\text{rnti},1}, \dots, x_{\text{rnti},15}$ , where  $x_{\text{rnti},0}$  corresponds to the MSB of the RNTI, to form the sequence of bits  $c_0, c_1, c_2, c_3, \dots, c_{K-1}$ . The relation between  $c_k$  and  $b_k$  is:

$$c_k = b_k \quad \text{for } k = 0, 1, 2, \dots, A+7$$

$$c_k = (b_k + x_{\text{rnti},k-A-8}) \bmod 2 \quad \text{for } k = A+8, A+9, A+10, \dots, A+23.$$

### 7.3.3 Channel coding

Information bits are delivered to the channel coding block. They are denoted by  $c_0, c_1, c_2, c_3, \dots, c_{K-1}$ , where  $K$  is the number of bits, and they are encoded via Polar coding according to Clause 5.3.1, by setting  $n_{\text{max}} = 9$ ,  $I_{\text{IL}} = 1$ ,  $n_{\text{PC}} = 0$ , and  $n_{\text{PC}}^{\text{wm}} = 0$ .

After encoding the bits are denoted by  $d_0, d_1, d_2, d_3, \dots, d_{N-1}$ , where  $N$  is the number of coded bits.

### 7.3.4 Rate matching

The input bit sequence to rate matching is  $d_0, d_1, d_2, \dots, d_{N-1}$ .

Rate matching is performed according to Clause 5.4.1 by setting  $I_{\text{BIL}} = 0$ .

The output bit sequence after rate matching is denoted as  $f_0, f_1, f_2, \dots, f_{E-1}$ .

---

## 8 Sidelink transport channels and control information

### 8.1 Sidelink broadcast channel

The processing for SL-BCH transport channel follows the BCH according to clause 7.1, with the following changes:

- In Clause 7.1, 'maximum of one transport block every 80ms' is replaced with 'maximum of one transport block'.
- Clause 7.1.1 for PBCH payload generation is not performed.
- Clause 7.1.2 for scrambling is not performed.
- In clause 7.1.5, the rate matching output sequence length  $E = 1386$  when higher layer parameter *cyclicPrefix* is configured, otherwise,  $E = 1782$ .

### 8.1.1 (void)

## 8.2 Sidelink shared channel

The processing for SL-SCH transport channel follows the UL-SCH according to clause 6.2, with the following changes:

- Rate matching of SL-SCH follows the rate matching according to clause 6.2.5 by setting  $I_{LBRM} = 0$
- Clause 6.2.7 is replaced by clause 8.2.1

### 8.2.1 Data and control multiplexing

Denote the coded bits for SL-SCH as  $g_0^{SL-SCH}, g_1^{SL-SCH}, g_2^{SL-SCH}, g_3^{SL-SCH}, \dots, g_{G^{SL-SCH}-1}^{SL-SCH}$ .

Denote the coded bits for the 2<sup>nd</sup>-stage SCI, as  $g_0^{SCI2}, g_1^{SCI2}, g_2^{SCI2}, g_3^{SCI2}, \dots, g_{G^{SCI2}-1}^{SCI2}$ .

Denote the multiplexed data and control coded bit sequence as  $g_0, g_1, \dots, g_{G-1}$ , where  $G$  is the total number of coded bits for transmission.

Assuming that  $N_L$  is the number of layers onto which the SL-SCH transport block is mapped, the multiplexed data and control coded bit sequence  $g_0, g_1, \dots, g_{G-1}$  is obtained as follows:

Denote  $Q_m^{SCI2}$  is modulation order of the 2<sup>nd</sup>-stage SCI.

if  $N_L = 1$ ,

for  $i = 0$  to  $G^{SCI2} + G^{SL-SCH} - 1$

if  $0 \leq i < G^{SCI2}$

$$g_i = g_i^{SCI2}$$

end if

if  $G^{SCI2} \leq i \leq G^{SCI2} + G^{SL-SCH} - 1$

$$g_i = g_{i-G^{SCI2}}^{SL-SCH}$$

end if

end for

end if

if  $N_L = 2$ ,

$$\text{let } M_{count,SCI2}^{RE} = G^{SCI2} / Q_m^{SCI2}$$

$$\text{set } m_{count}^{RE} = 0$$

for  $i = 0$  to  $M_{count,SCI2}^{RE} - 1$

for  $v = 0$  to  $N_L - 1$

for  $q = 0$  to  $Q_m^{SCI2} - 1$

if  $v = 0$

$$g_{m_{count}^{RE}} = g_{i \cdot Q_m^{SCI2} + q}^{SCI2}$$

else

$$g_{m_{count}^{RE}} = x \text{ // placeholder bit}$$

end if

$$m_{count}^{RE} = m_{count}^{RE} + 1$$

end for

end for

end for

for  $i = 0$  to  $G^{SL-SCH} - 1$

$$g_{m_{count}^{RE}} = g_i^{SL-SCH}$$

$$m_{count}^{RE} = m_{count}^{RE} + 1$$

end for

end if

## 8.3 Sidelink control information on PSCCH

SCI carried on PSCCH is a 1<sup>st</sup>-stage SCI, which transports sidelink scheduling information.

### 8.3.1 1<sup>st</sup>-stage SCI formats

The fields defined in each of the 1<sup>st</sup>-stage SCI formats below are mapped to the information bits  $a_0$  to  $a_{A-1}$  as follows:

Each field is mapped in the order in which it appears in the description, with the first field mapped to the lowest order information bit  $a_0$  and each successive field mapped to higher order information bits. The most significant bit of each field is mapped to the lowest order information bit for that field, e.g. the most significant bit of the first field is mapped to  $a_0$ .

#### 8.3.1.1 SCI format 1-A

SCI format 1-A is used for the scheduling of PSSCH and 2<sup>nd</sup>-stage-SCI on PSSCH

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

- Priority – 3 bits as specified in clause 5.4.3.3 of [12, TS 23.287] and clause 5.22.1.3.1 of [8, TS 38.321]. Value '000' of Priority field corresponds to priority value '1', value '001' of Priority field corresponds to priority value '2', and so on.
- Frequency resource assignment –  $\left\lceil \log_2 \left( \frac{N_{\text{subChannel}}^{\text{SL}} (N_{\text{subChannel}}^{\text{SL}} + 1)}{2} \right) \right\rceil$  bits when the value of the higher layer parameter  $sl\text{-}MaxNumPerReserve$  is configured to 2; otherwise  $\left\lceil \log_2 \left( \frac{N_{\text{subChannel}}^{\text{SL}} (N_{\text{subChannel}}^{\text{SL}} + 1) (2N_{\text{subChannel}}^{\text{SL}} + 1)}{6} \right) \right\rceil$  bits when the value of the higher layer parameter  $sl\text{-}MaxNumPerReserve$  is configured to 3, as defined in clause 8.1.5 of [6, TS 38.214].
- Time resource assignment – 5 bits when the value of the higher layer parameter  $sl\text{-}MaxNumPerReserve$  is configured to 2; otherwise 9 bits when the value of the higher layer parameter  $sl\text{-}MaxNumPerReserve$  is configured to 3, as defined in clause 8.1.5 of [6, TS 38.214].
- Resource reservation period –  $\left\lceil \log_2 N_{\text{rsv\_period}} \right\rceil$  bits as defined in clause 16.4 of [5, TS 38.213], where  $N_{\text{rsv\_period}}$  is the number of entries in the higher layer parameter  $sl\text{-}ResourceReservePeriodList$ , if higher layer parameter  $sl\text{-}MultiReserveResource$  is configured; 0 bit otherwise.
- DMRS pattern –  $\left\lceil \log_2 N_{\text{pattern}} \right\rceil$  bits as defined in clause 8.4.1.1.2 of [4, TS 38.211], where  $N_{\text{pattern}}$  is the number of DMRS patterns configured by higher layer parameter  $sl\text{-}PSSCH\text{-}DMRS\text{-}TimePatternList$ .
- 2<sup>nd</sup>-stage SCI format – 2 bits as defined in Table 8.3.1.1-1.

- Beta\_offset indicator – 2 bits as provided by higher layer parameter *sl-BetaOffsets2ndSCI* and Table 8.3.1.1-2.
- Number of DMRS port – 1 bit as defined in Table 8.3.1.1-3.
- Modulation and coding scheme – 5 bits as defined in clause 8.1.3 of [6, TS 38.214].
- Additional MCS table indicator – as defined in clause 8.1.3.1 of [6, TS 38.214]: 1 bit if one MCS table is configured by higher layer parameter *sl-Additional-MCS-Table*; 2 bits if two MCS tables are configured by higher layer parameter *sl-Additional-MCS-Table*; 0 bit otherwise.
- PSFCH overhead indication – 1 bit as defined clause 8.1.3.2 of [6, TS 38.214] if higher layer parameter *sl-PSFCH-Period* = 2 or 4; 0 bit otherwise.
- Reserved – a number of bits as determined by the following:
  - $N_{reserved}$  bits as configured by higher layer parameter *sl-NumReservedBits*, with value set to zero, if higher layer parameter *sl-IndicationUE-B* is not configured, or if higher layer parameter *sl-IndicationUE-B* is configured to 'disabled';
  - $(N_{reserved} - 1)$  bits otherwise, with value set to zero.
- Conflict information receiver flag – 0 or 1 bit
  - 1 bit if higher layer parameter *sl-IndicationUE-B* is configured to 'enabled', where the bit value of 0 indicates that the UE cannot be a UE to receive conflict information and the bit value of 1 indicates that the UE can be a UE to receive conflict information as defined in Clause 16.3.0 of [5, TS 38.213];
  - 0 bit otherwise.

**Table 8.3.1.1-1: 2<sup>nd</sup>-stage SCI formats**

| Value of 2nd-stage SCI format field | 2nd-stage SCI format |
|-------------------------------------|----------------------|
| 00                                  | SCI format 2-A       |
| 01                                  | SCI format 2-B       |
| 10                                  | SCI format 2-C       |
| 11                                  | Reserved             |

**Table 8.3.1.1-2: Mapping of Beta\_offset indicator values to indexes in Table 9.3-2 of [5, TS38.213]**

| Value of Beta_offset indicator | Beta_offset index in Table 9.3-2 of [5, TS38.213]                        |
|--------------------------------|--------------------------------------------------------------------------|
| 00                             | 1st index provided by higher layer parameter <i>sl-BetaOffsets2ndSCI</i> |
| 01                             | 2nd index provided by higher layer parameter <i>sl-BetaOffsets2ndSCI</i> |
| 10                             | 3rd index provided by higher layer parameter <i>sl-BetaOffsets2ndSCI</i> |
| 11                             | 4th index provided by higher layer parameter <i>sl-BetaOffsets2ndSCI</i> |

**Table 8.3.1.1-3: Number of DMRS port(s)**

| Value of the Number of DMRS port field | Antenna ports |
|----------------------------------------|---------------|
| 0                                      | 1000          |
| 1                                      | 1000 and 1001 |

## 8.3.2 CRC attachment

CRC attachment is performed according to clause 7.3.2 except that scrambling is not performed.

### 8.3.3 Channel coding

Channel coding is performed according to clause 7.3.3.

### 8.3.4 Rate Matching

Rate matching is performed according to clause 7.3.4.

## 8.4 Sidelink control information on PSSCH

SCI carried on PSSCH is a 2<sup>nd</sup>-stage SCI, which transports sidelink scheduling information, and/or inter-UE coordination related information.

### 8.4.1 2<sup>nd</sup>-stage SCI formats

The fields defined in each of the 2<sup>nd</sup>-stage SCI formats below are mapped to the information bits  $a_0$  to  $a_{A-1}$  as follows:

Each field is mapped in the order in which it appears in the description, with the first field mapped to the lowest order information bit  $a_0$  and each successive field mapped to higher order information bits. The most significant bit of each field is mapped to the lowest order information bit for that field, e.g. the most significant bit of the first field is mapped to  $a_0$ .

#### 8.4.1.1 SCI format 2-A

SCI format 2-A is used for the decoding of PSSCH, with HARQ operation when HARQ-ACK information includes ACK or NACK, when HARQ-ACK information includes only NACK, or when there is no feedback of HARQ-ACK information.

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

- HARQ process number – 4 bits.
- New data indicator – 1 bit.
- Redundancy version – 2 bits as defined in Table 7.3.1.1.1-2.
- Source ID – 8 bits as defined in clause 8.1 of [6, TS 38.214].
- Destination ID – 16 bits as defined in clause 8.1 of [6, TS 38.214].
- HARQ feedback enabled/disabled indicator – 1 bit as defined in clause 16.3 of [5, TS 38.213].
- Cast type indicator – 2 bits as defined in Table 8.4.1.1-1 and in clause 8.1 of [6, TS 38.214].
- CSI request – 1 bit as defined in clause 8.2.1 of [6, TS 38.214] and in clause 8.1 of [6, TS 38.214].

**Table 8.4.1.1-1: Cast type indicator**

| Value of Cast type indicator | Cast type                                                   |
|------------------------------|-------------------------------------------------------------|
| 00                           | Broadcast                                                   |
| 01                           | Groupcast<br>when HARQ-ACK information includes ACK or NACK |
| 10                           | Unicast                                                     |
| 11                           | Groupcast<br>when HARQ-ACK information includes only NACK   |

### 8.4.1.2 SCI format 2-B

SCI format 2-B is used for the decoding of PSSCH, with HARQ operation when HARQ-ACK information includes only NACK, or when there is no feedback of HARQ-ACK information.

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

- HARQ process number – 4 bits.
- New data indicator – 1 bit.
- Redundancy version – 2 bits as defined in Table 7.3.1.1.1-2.
- Source ID – 8 bits as defined in clause 8.1 of [6, TS 38.214].
- Destination ID – 16 bits as defined in clause 8.1 of [6, TS 38.214].
- HARQ feedback enabled/disabled indicator – 1 bit as defined in clause 16.3 of [5, TS 38.213].
- Zone ID – 12 bits as defined in clause 5.8.11 of [9, TS 38.331].
- Communication range requirement – 4 bits determined by higher layer parameter *sl-ZoneConfigMCR-Index*.

### 8.4.1.3 SCI format 2-C

SCI format 2-C is used for the decoding of PSSCH, and providing inter-UE coordination information or requesting inter-UE coordination information. SCI format 2-C can be used only for unicast.

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

- HARQ process number – 4 bits
- New data indicator – 1 bit
- Redundancy version – 2 bits as defined in Table 7.3.1.1.1-2
- Source ID – 8 bits as defined in clause 8.1 of [6, TS 38.214]
- Destination ID – 16 bits as defined in clause 8.1 of [6, TS 38.214]
- HARQ feedback enabled/disabled indicator – 1 bit as defined in clause 16.3 of [5, TS 38.213]
- CSI request – 1 bit as defined in clause 8.2.1 of [6, TS 38.214] and in clause 8.1 of [6, TS 38.214]
- Providing/Requesting indicator – 1 bit, where value 0 indicates SCI format 2-C is used for providing inter-UE coordination information and value 1 indicates SCI format 2-C is used for requesting inter-UE coordination information

If the 'Providing/Requesting indicator' field is set to 0, all the remaining fields are set as follows:

- Resource combinations –  $2 \cdot \left( \left\lceil \log_2 \left( \frac{N_{\text{subChannel}}^{\text{SL}} (N_{\text{subChannel}}^{\text{SL}} + 1) (2N_{\text{subChannel}}^{\text{SL}} + 1)}{6} \right) \right\rceil + 9 + Y \right)$  bits as defined in Clause 8.1.5A of [6, TS 38.214], where
  - $Y = \lceil \log_2 N_{\text{rsv\_period}} \rceil$  and  $N_{\text{rsv\_period}}$  is the number of entries in the higher layer parameter *sl-ResourceReservePeriodList*, if higher layer parameter *sl-MultiReserveResource* is configured;  $Y = 0$  otherwise
  - $N_{\text{subChannel}}^{\text{SL}}$  is the number of subchannels in a resource pool provided by the higher layer parameter *sl-NumSubchannel*
- First resource location – 8 bits as defined in Clause 8.1.5A of [6, TS 38.214].
- Reference slot location –  $(10 + \lceil \log_2 (10 \cdot 2^\mu) \rceil)$  bits as defined in Clause 8.1.5A of [6, TS 38.214], where  $\mu$  is defined in Table 4.2-1 of Clause 4.2 of [4, TS 38.211].

- Resource set type – 1 bit, where value 0 indicates preferred resource set and value 1 indicates non-preferred resource set.
- Lowest subChannel indices –  $2 \cdot \lceil \log_2 N_{\text{subChannel}}^{\text{SL}} \rceil$  bits as defined in Clause 8.1.5A of [6, TS 38.214].

If the 'Providing/Requesting indicator' field is set to 1, all the remaining fields are set as follows:

- Priority – 3 bits as specified in clause 5.4.3.3 of [12, TS 23.287] and clause 5.22.1.3.1 of [8, TS 38.321]. Value '000' of Priority field corresponds to priority value '1', value '001' of Priority field corresponds to priority value '2', and so on.
- Number of subchannels –  $\lceil \log_2 N_{\text{subChannel}}^{\text{SL}} \rceil$  bits as defined in Clause 8.1.4A of [6, TS 38.214].
- Resource reservation period –  $\lceil \log_2 N_{\text{rsv\_period}} \rceil$  bits as defined in Clause 8.1.4A of [6, TS 38.214], where  $N_{\text{rsv\_period}}$  is the number of entries in the higher layer parameter *sl-ResourceReservePeriodList*, if higher layer parameter *sl-MultiReserveResource* is configured; 0 bit otherwise.
- Resource selection window location –  $2 \cdot (10 + \lceil \log_2 (10 \cdot 2^\mu) \rceil)$  bits as defined in Clause 8.1.4A of [6, TS 38.214], where  $\mu$  is defined in Table 4.2-1 of Clause 4.2 of [4, TS 38.211].
- Resource set type – 1 bit, where value 0 indicates a request for inter-UE coordination information providing preferred resource set and value 1 indicates a request for inter-UE coordination information providing non-preferred resource set, if higher layer parameter *sl-DetermineResourceType* is configured to 'ueb'; otherwise, 0 bit.
- Padding bits.

For operation in a same resource pool, zeros shall be appended to SCI format 2-C of which 'Providing/Requesting indicator' field is set to 1 until the payload size equals that of SCI format 2-C of which 'Providing/Requesting indicator' field is set to 0.

## 8.4.2 CRC attachment

CRC attachment is performed according to clause 7.3.2 except that scrambling is not performed.

## 8.4.3 Channel coding

Channel coding is performed according to clause 7.3.3.

## 8.4.4 Rate Matching

For 2<sup>nd</sup>-stage SCI transmission on PSSCH with SL-SCH, the number of coded modulation symbols generated for 2<sup>nd</sup>-stage SCI transmission prior to duplication for the 2nd layer if present, denoted as  $Q'_{\text{SCI2}}$ , is determined as follows:

$$Q'_{\text{SCI2}} = \min \left\{ \left\lceil \frac{(O_{\text{SCI2}} + L_{\text{SCI2}}) \cdot \beta_{\text{offset}}^{\text{SCI2}}}{Q_m^{\text{SCI2}} \cdot R} \right\rceil, \left\lceil \alpha \sum_{l=0}^{N_{\text{symbol}}^{\text{PSSCH}}-1} M_{\text{sc}}^{\text{SCI2}}(l) \right\rceil \right\} + \gamma$$

where

- $O_{\text{SCI2}}$  is the number of the 2<sup>nd</sup>-stage SCI bits
- $L_{\text{SCI2}}$  is the number of CRC bits for the 2<sup>nd</sup>-stage SCI, which is 24 bits.
- $\beta_{\text{offset}}^{\text{SCI2}}$  is indicated in the corresponding 1<sup>st</sup>-stage SCI.
- $M_{\text{sc}}^{\text{PSSCH}}(l)$  is the scheduled bandwidth of PSSCH transmission, expressed as a number of subcarriers.
- $M_{\text{sc}}^{\text{PSSCH}}(l)$  is the number of subcarriers in OFDM symbol  $l$  that carry PSSCH and PSSCH DMRS associated with the PSSCH transmission.



- $M_{sc}^{SCI2}(l)$  is the number of resource elements that can be used for transmission of the 2<sup>nd</sup>-stage SCI in OFDM symbol  $l$ , for  $l = 0, 1, 2, \dots, N_{symbol}^{PSSCH} - 1$  and for  $N_{symbol}^{PSSCH} = N_{symbol}^{sh} - N_{symbol}^{PSFCH}$ , in PSSCH transmission, where  $N_{symbol}^{sh} = sl-lengthSymbols - 2$ , where  $sl-lengthSymbols$  is the number of sidelink symbols within the slot provided by higher layers as defined in [6, TS 38.214]. If higher layer parameter  $sl-PSFCH-Period = 2$  or  $4$ ,  $N_{symbol}^{PSFCH} = 3$  if "PSFCH overhead indication" field of SCI format 1-A indicates "1", and  $N_{symbol}^{PSFCH} = 0$  otherwise. If higher layer parameter  $sl-PSFCH-Period = 0$ ,  $N_{symbol}^{PSFCH} = 0$ . If higher layer parameter  $sl-PSFCH-Period$  is 1,  $N_{symbol}^{PSFCH} = 3$ .
- $M_{sc}^{SCI2}(l) = M_{sc}^{PSSCH}(l) - M_{sc}^{PSFCH}(l)$
- $\gamma$  is the number of vacant resource elements in the resource block to which the last coded symbol of the 2<sup>nd</sup>-stage SCI belongs.
- $R$  is the coding rate as indicated by "Modulation and coding scheme" field in SCI format 1-A.
- $\alpha$  is configured by higher layer parameter  $sl-Scaling$ .

The input bit sequence to rate matching is  $d_0, d_1, d_2, d_3, \dots, d_{N-1}$ , where  $N$  is the number of coded bits.

Rate matching is performed according to Clause 5.4.1 by setting  $l_{BL} = 1$ .

The output bit sequence after rate matching is denoted as  $g_0^{SCI2}, g_1^{SCI2}, g_2^{SCI2}, g_3^{SCI2}, \dots, g_{G^{SCI2}-1}^{SCI2}$ , where  $G^{SCI2} = Q_{SCI2}' \cdot Q_m^{SCI2}$  and  $Q_m^{SCI2}$  is modulation order of the 2<sup>nd</sup>-stage SCI. A UE is not expected to have  $G^{SCI2} > 4096$ .

#### 8.4.5 Multiplexing of coded 2<sup>nd</sup>-stage SCI bits to PSSCH

The coded 2<sup>nd</sup>-stage SCI bits are multiplexed onto PSSCH according to the procedures in Clause 8.2.1.

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## Annex <A> (informative): Change history

| Change history |          |            |      |     |     |                                                                                                                                            |             |
|----------------|----------|------------|------|-----|-----|--------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Date           | Meeting  | TDoc       | CR   | Rev | Cat | Subject/Comment                                                                                                                            | New version |
| 2017-05        | RAN1#89  | R1-1707082 |      |     |     | Draft skeleton                                                                                                                             | 0.0.0       |
| 2017-07        | AH_NR2   | R1-1712014 |      |     |     | Inclusion of LDPC related agreements                                                                                                       | 0.0.1       |
| 2017-08        | RAN1#90  | R1-1714564 |      |     |     | Inclusion of Polar coding related agreements                                                                                               | 0.0.2       |
| 2017-08        | RAN1#90  | R1-1714659 |      |     |     | Endorsed version by RAN1#90 as basis for further updates                                                                                   | 0.1.0       |
| 2017-09        | RAN1#90  | R1-1715322 |      |     |     | Capturing additional agreements on LDPC and Polar code from RAN1 #90                                                                       | 0.1.1       |
| 2017-09        | RAN#77   | RP-171991  |      |     |     | For information to plenary                                                                                                                 | 1.0.0       |
| 2017-09        | RAN1#90b | R1-1716928 |      |     |     | Capturing additional agreements on LDPC and Polar code from RAN1 NR AH#3                                                                   | 1.0.1       |
| 2017-10        | RAN1#90b | R1-1719106 |      |     |     | Endorsed as v1.1.0                                                                                                                         | 1.1.0       |
| 2017-11        | RAN1#91  | R1-1719225 |      |     |     | Capturing additional agreements on channel coding, etc.                                                                                    | 1.1.1       |
| 2017-11        | RAN1#91  | R1-1719245 |      |     |     | Capturing additional agreements on DCI format, channel coding, etc.                                                                        | 1.1.2       |
| 2017-11        | RAN1#91  | R1-1721049 |      |     |     | Endorsed as v1.2.0                                                                                                                         | 1.2.0       |
| 2017-12        | RAN1#91  | R1-1721342 |      |     |     | Capturing additional agreements on UCI, DCI, channel coding, etc.                                                                          | 1.2.1       |
| 2017-12        | RAN#78   | RP-172668  |      |     |     | Endorsed version for approval by plenary.                                                                                                  | 2.0.0       |
| 2017-12        | RAN#78   |            |      |     |     | Approved by plenary – Rel-15 spec under change control                                                                                     | 15.0.0      |
| 2018-03        | RAN#79   | RP-180200  | 0001 | -   | F   | CR capturing the Jan18 ad-hoc and RAN1#92 meeting agreements                                                                               | 15.1.0      |
| 2018-04        | RAN#79   |            |      |     |     | MCC: correction of typo in DCI format 0_1 (time domain resource assignment) – higher layer parameter should be <i>pusch-AllocationList</i> | 15.1.1      |
| 2018-06        | RAN#80   | RP-181172  | 0002 | 1   | F   | CR to 38.212 capturing the RAN1#92bis and RAN1#93 meeting agreements                                                                       | 15.2.0      |
| 2018-06        | RAN#80   | RP-181257  | 0003 | -   | B   | CR to 38.212 capturing the RAN1#92bis and RAN1#93 meeting agreements related to URLLC                                                      | 15.2.0      |
| 2018-09        | RAN#81   | RP-181789  | 0004 | -   | F   | CR to 38.212 capturing the RAN1#94 meeting agreements                                                                                      | 15.3.0      |
| 2018-12        | RAN#82   | RP-182523  | 0005 | 3   | F   | Combined CR of all essential corrections to 38.212 from RAN1#94bis and RAN1#95                                                             | 15.4.0      |
| 2019-03        | RAN#83   | RP-190448  | 0006 | -   | F   | Correction of wrong implementation on frequency domain resource assignment bitwidth                                                        | 15.5.0      |
| 2019-03        | RAN#83   | RP-190448  | 0008 | -   | F   | Correction to UCI multiplexing                                                                                                             | 15.5.0      |
| 2019-03        | RAN#83   | RP-190448  | 0009 | -   | F   | Correction on DCI format 2_3 for SUL cell in TS 38.212                                                                                     | 15.5.0      |
| 2019-03        | RAN#83   | RP-190448  | 0010 | -   | F   | Corrections to TS38.212                                                                                                                    | 15.5.0      |
| 2019-03        | RAN#83   | RP-190448  | 0011 | -   | F   | On bitwidth calculation for DCI fields using RRC parameter indicating maximum number of MIMO layers per serving cell                       | 15.5.0      |
| 2019-03        | RAN#83   | RP-190448  | 0012 | -   | F   | CR on zero-padding of DCI 1_1 in cross-carrier scheduling case                                                                             | 15.5.0      |
| 2019-03        | RAN#83   | RP-190448  | 0013 | -   | F   | Clarification on UL SUL indicator field and SRS request field                                                                              | 15.5.0      |
| 2019-06        | RAN#84   | RP-191282  | 0014 | -   | F   | CR on correction to bitwidth of NNZC indicator                                                                                             | 15.6.0      |
| 2019-06        | RAN#84   | RP-191282  | 0015 | -   | F   | Correction on DCI size alignment in TS 38.212                                                                                              | 15.6.0      |
| 2019-06        | RAN#84   | RP-191282  | 0016 | -   | F   | Correction on UL/SUL indicator in DCI format 0_0                                                                                           | 15.6.0      |
| 2019-06        | RAN#84   | RP-191282  | 0017 | -   | F   | Corrections to 38.212 including alignment of terminology across specifications                                                             | 15.6.0      |
| 2019-06        | RAN#84   | RP-191282  | 0018 | -   | F   | CR on maximum modulation order configured for serving cell                                                                                 | 15.6.0      |
| 2019-06        | RAN#84   | RP-191282  | 0019 | 1   | F   | Corrections to 38.212 including alignment of terminology across specifications from RAN1#97                                                | 15.6.0      |
| 2019-09        | RAN#85   | RP-191941  | 0020 | -   | F   | Corrections to 38.212 including alignment of terminology across specifications in RAN1#98                                                  | 15.7.0      |
| 2019-12        | RAN#86   | RP-192625  | 0021 | -   | F   | CR on UL/SUL indicator in DCI format 0_1                                                                                                   | 15.8.0      |
| 2019-12        | RAN#86   | RP-192625  | 0022 | -   | F   | Corrections to 38.212 including alignment of terminology across specifications in RAN1#98bis and RAN1#99                                   | 15.8.0      |
| 2019-12        | RAN#86   | RP-192636  | 0023 | -   | B   | Introduction of NR based access to unlicensed spectrum into 38.212                                                                         | 16.0.0      |
| 2019-12        | RAN#86   | RP-192637  | 0024 | -   | B   | Introduction of IAB into 38.212                                                                                                            | 16.0.0      |
| 2019-12        | RAN#86   | RP-192638  | 0025 | -   | B   | Introduction of 5G V2X sidelink features into TS 38.212                                                                                    | 16.0.0      |
| 2019-12        | RAN#86   | RP-192639  | 0026 | -   | B   | Introduction of Physical Layer Enhancements for NR URLLC                                                                                   | 16.0.0      |
| 2019-12        | RAN#86   | RP-192641  | 0027 | -   | B   | Introduction of Enhancements on NR MIMO                                                                                                    | 16.0.0      |
| 2019-12        | RAN#86   | RP-192642  | 0028 | -   | B   | Introduction of power saving in 38.212                                                                                                     | 16.0.0      |
| 2019-12        | RAN#86   | RP-192645  | 0029 | -   | B   | Introduction of MR DC/CA                                                                                                                   | 16.0.0      |
| 2019-12        | RAN#86   | RP-192643  | 0030 | -   | B   | Introduction of NR positioning support                                                                                                     | 16.0.0      |
| 2019-12        | RAN#86   | RP-192635  | 0031 | -   | B   | Introduction of two-step RACH                                                                                                              | 16.0.0      |
| 2020-03        | RAN#87-e | RP-200185  | 0032 | -   | F   | Corrections for Rel-16 NR-U after RAN1#100-e                                                                                               | 16.1.0      |

|         |          |           |      |   |   |                                                                                                |        |
|---------|----------|-----------|------|---|---|------------------------------------------------------------------------------------------------|--------|
| 2020-03 | RAN#87-e | RP-200190 | 0033 | - | F | Corrections for NR MIMO after RAN1#100-e                                                       | 16.1.0 |
| 2020-03 | RAN#87-e | RP-200188 | 0034 | - | F | Corrections for URLLC after RAN1#100-e                                                         | 16.1.0 |
| 2020-03 | RAN#87-e | RP-200191 | 0035 | - | F | Corrections for power saving after RAN1#100-e                                                  | 16.1.0 |
| 2020-03 | RAN#87-e | RP-200187 | 0036 | - | F | Corrections on 5G V2X sidelink features after RAN1#100-e                                       | 16.1.0 |
| 2020-06 | RAN#88-e | RP-200683 | 0038 | - | A | CR on L1-RSRP report on PUSCH                                                                  | 16.2.0 |
| 2020-06 | RAN#88-e | RP-200693 | 0039 | 1 | F | Corrections for power saving                                                                   | 16.2.0 |
| 2020-06 | RAN#88-e | RP-200689 | 0040 | 1 | F | Corrections on 5G V2X sidelink features after RAN1#100bis-e and RAN1#101-e                     | 16.2.0 |
| 2020-06 | RAN#88-e | RP-200694 | 0041 | 1 | F | Corrections in TS 38.212 for NR positioning                                                    | 16.2.0 |
| 2020-06 | RAN#88-e | RP-200692 | 0042 | 1 | F | Corrections in TS 38.212 for NR MIMO                                                           | 16.2.0 |
| 2020-06 | RAN#88-e | RP-200696 | 0043 | - | F | Corrections for Rel-16 MR-DC/CA after RAN1#100bis-e                                            | 16.2.0 |
| 2020-06 | RAN#88-e | RP-200690 | 0044 | 1 | F | Corrections on NR eURLLC                                                                       | 16.2.0 |
| 2020-06 | RAN#88-e | RP-200687 | 0045 | 1 | F | Corrections for Rel-16 NR-U                                                                    | 16.2.0 |
| 2020-06 | RAN#88-e | RP-200688 | 0046 | - | F | Corrections for NR IAB                                                                         | 16.2.0 |
| 2020-09 | RAN#89-e | RP-201814 | 0047 | - | F | Correction on UCI bit sequence generation                                                      | 16.3.0 |
| 2020-09 | RAN#89-e | RP-201803 | 0049 | - | A | CR on PTRS for TS 38.212                                                                       | 16.3.0 |
| 2020-09 | RAN#89-e | RP-201810 | 0050 | - | F | Alignment of RRC parameter <i>ps-RNTI</i>                                                      | 16.3.0 |
| 2020-09 | RAN#89-e | RP-201813 | 0051 | - | F | CR to 38.212 on RRC parameter alignment for SCell dormancy                                     | 16.3.0 |
| 2020-09 | RAN#89-e | RP-201807 | 0052 | - | F | Corrections on 5G V2X sidelink features                                                        | 16.3.0 |
| 2020-09 | RAN#89-e | RP-201809 | 0053 | - | F | Corrections to MIMO enhancements                                                               | 16.3.0 |
| 2020-09 | RAN#89-e | RP-201805 | 0054 | - | F | Corrections to MIMO enhancements                                                               | 16.3.0 |
| 2020-09 | RAN#89-e | RP-201808 | 0055 | - | F | Corrections on NR eURLLC                                                                       | 16.3.0 |
| 2020-12 | RAN#90-e | RP-202390 | 0056 | - | F | RRC IE name fix to dynamic frequency domain resource allocation type selection (Rel-15 origin) | 16.4.0 |
| 2020-12 | RAN#90-e | RP-202384 | 0057 | - | F | Correction on Transmission configuration indication in DCI format 1_2                          | 16.4.0 |
| 2020-12 | RAN#90-e | RP-202398 | 0058 | - | F | Alignment CR for TS 38.212                                                                     | 16.4.0 |
| 2021-03 | RAN#91-e | RP-210052 | 0059 | - | F | CR on DMRS                                                                                     | 16.5.0 |
| 2021-03 | RAN#91-e | RP-210049 | 0060 | - | F | Correction to description of FDRA field size in DCI 0_0                                        | 16.5.0 |
| 2021-03 | RAN#91-e | RP-210049 | 0061 | - | F | Correction to description of FDRA field interpretation in DCI 0_1                              | 16.5.0 |
| 2021-03 | RAN#91-e | RP-210050 | 0062 | - | F | Correction on Sidelink Broadcast channel                                                       | 16.5.0 |
| 2021-03 | RAN#91-e | RP-210049 | 0063 | - | F | Correction on LBT Type and CP Extension Indication for Semi-Static Channel Occupancy           | 16.5.0 |
| 2021-03 | RAN#91-e | RP-210059 | 0064 | - | F | Alignment CR for TS 38.212                                                                     | 16.5.0 |
| 2021-06 | RAN#92-e | RP-211252 | 0066 | - | F | 38.212 CR on DAI size determination for DCI format 1_1/1-2 in CA                               | 16.6.0 |
| 2021-06 | RAN#92-e | RP-211236 | 0067 | - | F | Corrections on parameter of MCS table set to qam256                                            | 16.6.0 |
| 2021-06 | RAN#92-e | RP-211234 | 0068 | - | D | Alignment CR for TS 38.212 (post RAN1#104bis-e)                                                | 16.6.0 |
| 2021-06 | RAN#92-e | RP-211234 | 0069 | - | F | Correction on HARQ-ACK codebook RRC parameter                                                  | 16.6.0 |
| 2021-06 | RAN#92-e | RP-211236 | 0070 | - | F | Correction on SRS resource set configuration in TS 38.212                                      | 16.6.0 |

|         |          |           |      |   |   |                                                                                         |        |
|---------|----------|-----------|------|---|---|-----------------------------------------------------------------------------------------|--------|
| 2021-06 | RAN#92-e | RP-211243 | 0071 | - | F | Alignment CR for TS 38.212 (post RAN1#105-e)                                            | 16.6.0 |
| 2021-09 | RAN#93-e | RP-211843 | 0072 | - | F | Correction on SRS resource set configuration for DCI format 0_2 in TS 38.212            | 16.7.0 |
| 2021-09 | RAN#93-e | RP-211841 | 0074 | - | A | Rel-15 editorial corrections for TS 38.212 (mirrored to Rel-16)                         | 16.7.0 |
| 2021-09 | RAN#93-e | RP-211850 | 0075 | - | F | Alignment CR for TS 38.212                                                              | 16.7.0 |
| 2021-12 | RAN#94-e | RP-212959 | 0076 | - | F | Correction on mapping between priority field value and priority value in SCI format 1-A | 16.8.0 |
| 2021-12 | RAN#94-e | RP-212961 | 0077 | - | F | Changes of channel access types tables in TS 38.212                                     | 16.8.0 |
| 2021-12 | RAN#94-e | RP-212961 | 0078 | - | F | Corrections on CG-UCI multiplexing in TS38.212                                          | 16.8.0 |
| 2021-12 | RAN#94-e | RP-212958 | 0080 | - | A | Clarify UCI bitwidth and UCI mapping order for non-PMI based CSI feedback               | 16.8.0 |
| 2021-12 | RAN#94-e | RP-213238 | 0081 | - | F | Clarification on KNZ to codepoint mapping for eType II CSI                              | 16.8.0 |
| 2021-12 | RAN#94-e | RP-212958 | 0083 | - | A | Rel-15 editorial corrections for TS 38.212 (mirrored to Rel-16)                         | 16.8.0 |
| 2021-12 | RAN#94-e | RP-212964 | 0084 | - | F | Alignment CR for TS 38.212                                                              | 16.8.0 |
| 2021-12 | RAN#94-e | RP-212967 | 0085 | - | B | Introduction of features to extend current NR operation to 71 GHz                       | 17.0.0 |
| 2021-12 | RAN#94-e | RP-212982 | 0086 | - | B | Introduction of NR DL 1024QAM for FR1                                                   | 17.0.0 |
| 2021-12 | RAN#94-e | RP-212973 | 0087 | - | B | Introduction of Coverage Enhancements                                                   | 17.0.0 |
| 2021-12 | RAN#94-e | RP-212979 | 0088 | - | B | Introduction of NR Multicast and Broadcast Services                                     | 17.0.0 |
| 2021-12 | RAN#94-e | RP-212966 | 0089 | - | B | Introduction of Further enhancements on MIMO for NR                                     | 17.0.0 |
| 2021-12 | RAN#94-e | RP-212969 | 0090 | - | B | Introduction of NR non-terrestrial networks (NTN)                                       | 17.0.0 |
| 2021-12 | RAN#94-e | RP-212972 | 0091 | - | B | Introduction of Rel-17 UE power saving enhancements                                     | 17.0.0 |
| 2021-12 | RAN#94-e | RP-212968 | 0092 | - | B | Introduction of Rel-17 enhanced IIoT and URLLC                                          | 17.0.0 |
| 2021-12 | RAN#94-e | RP-212980 | 0093 | - | B | Introduction of NR dynamic spectrum sharing enhancements                                | 17.0.0 |
| 2021-12 | RAN#94-e | RP-212978 | 0094 | - | B | Introduction of NR sidelink enhancement                                                 | 17.0.0 |
| 2022-03 | RAN#95-e | RP-220269 | 0096 | - | A | Correction of NZC partitioning in eType II CSI                                          | 17.1.0 |
| 2022-03 | RAN#95-e | RP-220248 | 0098 | - | A | Correction on Rel-16 UE dormancy adaptation                                             | 17.1.0 |
| 2022-03 | RAN#95-e | RP-220252 | 0099 | - | F | Corrections on enhanced IIoT and URLLC in 38.212                                        | 17.1.0 |
| 2022-03 | RAN#95-e | RP-220262 | 0100 | - | F | Corrections on NR sidelink enhancement in 38.212                                        | 17.1.0 |
| 2022-03 | RAN#95-e | RP-220257 | 0101 | - | F | Corrections on coverage enhancements in 38.212                                          | 17.1.0 |
| 2022-03 | RAN#95-e | RP-220263 | 0102 | - | F | Corrections on NR Multicast and Broadcast Services in 38.212                            | 17.1.0 |
| 2022-03 | RAN#95-e | RP-220256 | 0103 | - | F | Corrections on UE power saving enhancements in 38.212                                   | 17.1.0 |
| 2022-03 | RAN#95-e | RP-220251 | 0104 | - | F | Correction on extension of current NR operation to 71 GHz in 38.212                     | 17.1.0 |
| 2022-03 | RAN#95-e | RP-220264 | 0105 | - | F | Corrections on NR dynamic spectrum sharing enhancements in 38.212                       | 17.1.0 |
| 2022-03 | RAN#95-e | RP-220250 | 0106 | - | F | Corrections on Further enhancements on MIMO for NR in TS 38.212                         | 17.1.0 |
| 2022-06 | RAN#96   | RP-221617 | 0108 | - | A | Clarification of TPMI indication for UL full power transmission                         | 17.2.0 |
| 2022-06 | RAN#96   | RP-221602 | 0109 | - | F | Corrections on enhanced IIoT and URLLC in 38.212                                        | 17.2.0 |
| 2022-06 | RAN#96   | RP-221612 | 0110 | - | F | Corrections on NR Multicast and Broadcast Services in 38.212                            | 17.2.0 |

|         |          |           |      |   |   |                                                                                       |        |
|---------|----------|-----------|------|---|---|---------------------------------------------------------------------------------------|--------|
| 2022-06 | RAN#96   | RP-221606 | 0111 | - | F | Corrections on UE power saving enhancements in 38.212                                 | 17.2.0 |
| 2022-06 | RAN#96   | RP-221601 | 0112 | - | F | Correction on extension of current NR operation to 71 GHz in 38.212                   | 17.2.0 |
| 2022-06 | RAN#96   | RP-221600 | 0113 | - | F | Corrections on Further enhancements on MIMO for NR in TS 38.212                       | 17.2.0 |
| 2022-06 | RAN#96   | RP-221599 | 0115 | - | A | Rel-16 editorial corrections for TS 38.212 (mirrored to Rel-17)                       | 17.2.0 |
| 2022-09 | RAN#97-e | RP-222403 | 0116 | 1 | F | CR on DCI size for Rel-17 NTN HARQ in 38.212                                          | 17.3.0 |
| 2022-09 | RAN#97-e | RP-222400 | 0117 | - | F | CR on the description of the SRS resource set indication for PUSCH repetition         | 17.3.0 |
| 2022-09 | RAN#97-e | RP-222401 | 0118 | - | F | CR on ChannelAccess-Cpext in Fallback DCI                                             | 17.3.0 |
| 2022-09 | RAN#97-e | RP-222413 | 0119 | - | F | CR on DCI size alignment for Cross-carrier scheduling from SCell to PCell             | 17.3.0 |
| 2022-09 | RAN#97-e | RP-222406 | 0120 | - | F | Corrections on UE Power Saving Enhancements for NR in TS 38.212                       | 17.3.0 |
| 2022-09 | RAN#97-e | RP-222412 | 0121 | - | F | Corrections on NR Multicast and Broadcast Services in 38.212                          | 17.3.0 |
| 2022-09 | RAN#97-e | RP-222411 | 0122 | - | F | Correction on NR sidelink enhancement                                                 | 17.3.0 |
| 2022-09 | RAN#97-e | RP-222422 | 0123 | - | F | Rel-17 editorial corrections for TS 38.212                                            | 17.3.0 |
| 2022-12 | RAN#98-e | RP-222863 | 0124 | - | F | Corrections on resource pool index                                                    | 17.4.0 |
| 2022-12 | RAN#98-e | RP-222853 | 0125 | - | F | CR on channel access type indication in non-fallback DCI                              | 17.4.0 |
| 2022-12 | RAN#98-e | RP-222853 | 0126 | - | F | Correction to support up to 32 HARQ process numbers for FR2-2                         | 17.4.0 |
| 2022-12 | RAN#98-e | RP-222853 | 0127 | - | F | Correction on TDRA for multiple PUSCH scheduling in TS 38.212                         | 17.4.0 |
| 2022-12 | RAN#98-e | RP-222854 | 0128 | - | F | CR on priority of CG-UCI                                                              | 17.4.0 |
| 2022-12 | RAN#98-e | RP-222864 | 0129 | - | F | CR on number of HARQ-ACK codebooks configurable for multicast                         | 17.4.0 |
| 2022-12 | RAN#98-e | RP-222865 | 0130 | - | F | CR on DCI size alignment for Cross-carrier scheduling from SCell to PCell             | 17.4.0 |
| 2022-12 | RAN#98-e | RP-222868 | 0131 | 1 | F | Rel-17 editorial corrections for TS 38.212                                            | 17.4.0 |
| 2022-12 | RAN#98-e | RP-222858 | 0132 | - | F | Correction on the short message indicator when TRS availability indication is present | 17.4.0 |
| 2022-12 | RAN#98-e | RP-222864 | 0133 | - | F | CR on format 4_0 DCI size alignment in SCell                                          | 17.4.0 |
| 2022-12 | RAN#98-e | RP-222870 | 0134 | - | F | CR on CSI reporting                                                                   | 17.4.0 |
| 2023-03 | RAN#99   | RP-230451 | 0135 | - | F | CR on aligning DCI sizes when configuring two HARQ-ACK codebooks for multicast        | 17.5.0 |
| 2023-03 | RAN#99   | RP-230443 | 0136 | - | F | Corrections on intra-UE multiplexing and semi-static channel occupancy                | 17.5.0 |
| 2023-03 | RAN#99   | RP-230442 | 0137 | - | F | CR on DCI field sizes for multiple PDSCHs scheduled by single DCI                     | 17.5.0 |
| 2023-03 | RAN#99   | RP-230442 | 0138 | - | F | Corrections to ChannelAccess-CPext field in DCI formats x_2 in TS38.212               | 17.5.0 |
| 2023-03 | RAN#99   | RP-230440 | 0140 | - | A | Rel-16 editorial corrections for TS 38.212 (mirrored to Rel-17)                       | 17.5.0 |
| 2023-03 | RAN#99   | RP-230453 | 0141 | - | F | Rel-17 editorial corrections for TS 38.212                                            | 17.5.0 |
| 2023-09 | RAN#101  | RP-232445 | 0142 | - | F | Correction for the mapping of rank combination value for Rel-17 NCJT CSI              | 17.6.0 |
| 2023-09 | RAN#101  | RP-232531 | 0143 | - | F | Rel-17 editorial corrections for TS 38.212                                            | 17.6.0 |

|         |         |           |      |   |   |                                                                                                       |         |
|---------|---------|-----------|------|---|---|-------------------------------------------------------------------------------------------------------|---------|
| 2023-12 | RAN#102 | RP-233703 | 0157 | 1 | A | Correction on the rate matching when HARQ-ACK multiplexed with CG-PUSCH                               | 17.7.0  |
| 2023-12 | RAN#102 | RP-233727 | 0159 | - | F | Correction on CSI reporting for 1 CSI-RS port                                                         | 17.7.0  |
| 2023-12 | RAN#102 | RP-233728 | 0161 | - | F | Rel-17 editorial corrections for TS 38.212                                                            | 17.7.0  |
| 2024-03 | RAN#103 | RP-240534 | 0175 | - | F | Clarification on typeA SRS TPC commands for SUL                                                       | 17.8.0  |
| 2024-03 | RAN#103 | RP-240515 | 0177 | - | F | CR on reportQuantity for RSRP/SINR in TS38.212                                                        | 17.8.0  |
| 2024-03 | RAN#103 | RP-240536 | 0180 | - | A | Rel-16 editorial corrections for TS 38.212 (mirrored to Rel-17)                                       | 17.8.0  |
| 2024-06 | RAN#104 | RP-241064 | 0190 | - | A | Correction to maxRank configuration restriction with fullpowerMode1 and transform precoding 'enabled' | 17.9.0  |
| 2024-06 | RAN#104 | RP-241059 | 0198 | - | F | Rel-17 editorial corrections for TS 38.212                                                            | 17.9.0  |
| 2024-06 | RAN#104 | RP-241058 | 0201 | - | A | Rel-16 editorial corrections for TS 38.212 (mirrored to Rel-17)                                       | 17.9.0  |
| 2024-12 | RAN#106 | RP-242932 | 0207 | - | F | CR on PTRS-DMRS Association                                                                           | 17.10.0 |
| 2025-03 | RAN#107 | RP-250231 | 0211 | - | F | Correction on LBRM TBS determination for UE indicating 1024QAM rank restricted capability             | 17.11.0 |
| 2025-06 | RAN#108 | RP-251562 | 0223 | - | F | Rel-17 editorial corrections for TS 38.212                                                            | 17.12.0 |

History

| Document history |                |             |
|------------------|----------------|-------------|
| V17.1.0          | April 2022     | Publication |
| V17.2.0          | July 2022      | Publication |
| V17.3.0          | September 2022 | Publication |
| V17.4.0          | January 2023   | Publication |
| V17.5.0          | April 2023     | Publication |
| V17.6.0          | October 2023   | Publication |
| V17.7.0          | February 2024  | Publication |
| V17.8.0          | April 2024     | Publication |
| V17.9.0          | August 2024    | Publication |
| V17.10.0         | January 2025   | Publication |
| V17.11.0         | April 2025     | Publication |
| V17.12.0         | July 2025      | Publication |