**3GPP TSG-RAN WG1 Meeting #103eR1-20xxxxx**

**Elbonia, October 26 – November 13, 2020**

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| *CR-Form-v12.0* | | | | | | | | |
| **DRAFT CHANGE REQUEST** | | | | | | | | |
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|  | **36.211** | **CR** |  | **rev** |  | **Current version:** | **16.3.0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

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| ***Title:*** | Alignment of parameter names | | | | | | | | | |
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| ***Source to WG:*** | Ericsson | | | | | | | | | |
| ***Source to TSG:*** |  | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** |  | | | | |  | ***Date:*** | | | 2020-11-04 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | F |  | | | | | ***Release:*** | | | Rel-16 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) Rel-12 (Release 12)* *Rel-13 (Release 13) Rel-14 (Release 14) Rel-15 (Release 15) Rel-16 (Release 16)* | |
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| ***Reason for change:*** | | Alignment of terminology between specifications | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | * Changing PUR C-RNTI to PUR-RNTI (R1-2009296) * Replacing “resourceReservationDedicated[DL/UL] is configured” with “[uplink/downlink] resource reservation is enabled for the UE as specified in [9]” (R1-2009296) | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | Inconsistent terminology across specifications | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  |  | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  |  | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  |  | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

### 5.3.4 Mapping to physical resources

For each antenna port  used for transmission of the PUSCH in a subframe the block of complex-valued symbols  shall be multiplied with the amplitude scaling factor  in order to conform to the transmit power specified in clause 5.1.1.1 in 3GPP TS 36.213 [4], and mapped in sequence starting with  to physical resource blocks on antenna port  and assigned for transmission of PUSCH. The relation between the index  and the antenna port number  is given by Table 5.2.1-1. The mapping to resource elements  corresponding to the physical resource blocks assigned for transmission shall fulfil the following criteria:

- not used for transmission of reference signals, and

- not part of the last SC-FDMA symbol in a subframe, if the UE transmits SRS in the same subframe in the same serving cell, and

- not part of the last SC-FDMA symbol in a subframe configured with cell-specific SRS for non-BL/CE UEs and BL/CE UEs in CEModeA, if the PUSCH transmission partly or fully overlaps with the cell-specific SRS bandwidth, and

- not part of an SC-FDMA symbol reserved for possible trigger type 1 SRS transmission as specified in [4] in a UE-specific aperiodic SRS subframe in the same serving cell, and

- not part of an SC-FDMA symbol reserved for possible trigger type 0 SRS transmission as specified in [4] in a UE-specific periodic SRS subframe in the same serving cell when the UE is configured with multiple TAGs

- not part of the first SC-FDMA symbol in a subframe if the associated DCI indicates PUSCH starting position '01', '10', or '11' and does not indicate PUSCH mode 2.

- not part of the first SC-FDMA symbol in the second slot in a subframe if the associated DCI indicates PUSCH starting position '01', '10', or '11' and PUSCH mode 2.

- not part of the last SC-FDMA symbol in a subframe if the associated DCI indicates PUSCH ending symbol '1' and does not indicate PUSCH mode 3.

- not part of the second slot in a subframe if the associated DCI indicates PUSCH ending symbol '0' and PUSCH mode 3.

- not part of SC-FDMA symbols 5 to 13 in a subframe if the associated DCI indicates PUSCH ending symbol '1' and PUSCH mode 3.

The mapping to resource elements  shall be in increasing order of first the index , then the index . The mapping starts with the first slot in an uplink subframe, except for slot-PUSCH, subslot-PUSCH transmission, or PUSCH mode 2.

In case of PUSCH transmissions using sub-PRB allocations for BL/CE UEs, the mapping starts over in every valid uplink subframe composing an UL resource unit.

In case of slot-PUSCH, the mapping shall start at  in the slot assigned for transmission.

In case of PUSCH mode 2, the mapping shall start at  in the second slot of the subframe assigned for transmission.

In case of subslot-PUSCH, the mapping shall start at symbol  where the start of the mapping is dependent on the uplink subslot number in the subframe assigned for transmission and the *DMRS-pattern* field in the related uplink DCI format [3] according to Table 5.3.4-1 where starting symbol index "4" for subslot #5 is applied if the UE has indicated the capability *ul-pattern-ddd-r15*.

Table 5.3.4-1: Starting symbol index for subslot-PUSCH transmission

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *DMRS-pattern* field in uplink-related DCI format [3] | Uplink subslot number | | | | | |
| #0 | #1 | #2 | #3 | #4 | #5 |
| 00 | 1 | 4 | 6 | 1 | 3 | 5 |
| 01 | 0 | 3 | 5 | 0 | 2 | 4 |
| 10 | – | 3 | – | 0 | 2 | – |
| 11 | – | 3 | – | – | 2 | – |

In case of a semi-persistently scheduled subslot-PUSCH, and semi-persistent scheduling (i.e. higher layer parameter *sps-ConfigUL-STTI* is configured, see 3GPP TS 36.331 [9]) with a configured periodicity of 1 subslot (i.e. *semiPersistSchedIntervalUL-STTI* set to *sTTI1*), the mapping shall start at symbol  depending on the *DMRS-pattern* field in the related uplink DCI format [3] according to Table 5.3.4-2.

In case of a semi-persistently scheduled subslot-PUSCH and semi-persistent scheduling (the higher layer parameter *sps-ConfigUL-sTTI-r15* is configured, see 3GPP TS 36.331 [9]) with repetitions enabled (the higher layer parameter *totalNumberPUSCH-SPS-STTI-UL-Repetitions* is configured), the mapping shall start at symbol  depending on the *DMRS-pattern* field in the related uplink DCI format [3] according to Table 5.3.4-2.

Table 5.3.4-2: Starting symbol index for subslot-PUSCH transmission in case of semi-persistent scheduling with a configured periodicity of 1 subslot

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *DMRS-pattern* field in uplink-related DCI format [3] | Uplink subslot number | | | | | |
| #0 | #1 | #2 | #3 | #4 | #5 |
| 00 | 1 | 4 | 6 | 1 | 3 | 5 |
| 10 | 1 | 3 | 6 | 0 | 3 | 5 |

In case of subslot-PUSCH and semi-persistent scheduling with a configured periodicity longer than 1 subslot the mapping shall start at symbol  according to the first row of Table 5.3.4-2 (i.e. equivalent to a signalling of *DMRS-pattern* field set to '00').

For the UpPTS, the mapping shall start at symbol  and if *dmrsLess-UpPts* is set to true the mapping shall end at symbol  in the second slot of a special subframe, otherwise, the mapping shall end at symbol  in the second slot of a special subframe.

For BL/CE UEs, the PUSCH transmission is restricted as follows:

- For CEModeA, if the PUSCH is associated with C-RNTI or SPS C-RNTI and the higher layer parameter *ce-pusch-maxBandwidth-config* is set to 5 MHz, the maximum number of allocatable PRBs for PUSCH is 24 PRBs. The allocatable PRBs include the PRBs belonging to the narrowbands defined in clause 5.2.4 and the odd PRB at the center of the uplink system bandwidth in case of odd total number of uplink PRBs. If a resource assignment or frequency hopping would result in a PUSCH resource allocation outside the allocatable PRBs then the PUSCH transmission in that subframe is dropped.

- For all other cases, the maximum number of allocatable PRBs for PUSCH is 6 PRBs restricted to one of the narrowbands defined in clause 5.2.4.

For BL/CE UEs in CEModeB, resource elements in the last SC-FDMA symbol in a subframe configured with cell-specific SRS shall be counted in the PUSCH mapping but not used for transmission of the PUSCH.

For BL/CE UEs, if one or more SC-FDMA symbol(s) are left empty due to guard period for narrowband or wideband retuning, the affected SC-FDMA symbol(s) shall be counted in the PUSCH mapping but not used for transmission of the PUSCH.

For a UE configured with SRS carrier switching, if the first symbol in a subframe overlaps with an SRS transmission (including any interruption due to uplink or downlink RF retuning time) in a carrier without PUSCH/PUCCH, the resource elements in the first SC-FDMA symbol shall be counted in the PUSCH mapping but not used for transmission of PUSCH.

For a UE configured with SRS carrier switching, if the last symbol in a subframe is counted in the PUSCH mapping and the last symbol in the subframe overlaps with an SRS transmission (including any interruption due to uplink or downlink RF retuning time) in a carrier without PUSCH/PUCCH, the resource elements in the last SC-FDMA symbol shall be counted in the PUSCH mapping but not used for transmission of PUSCH.

For a UE configured with SRS carrier switching, if the last symbol in a subframe is not counted in the PUSCH mapping and the second-to-last symbol in the subframe overlaps with an SRS transmission (including any interruption due to uplink or downlink RF retuning time) in a carrier without PUSCH/PUCCH, the resource elements in the second-to-last SC-FDMA symbol shall be counted in the PUSCH mapping but not used for transmission of PUSCH.

For a UE configured with PUSCH Mode 1, if DCI indicates PUSCH mode 1 enabled and the corresponding transmission of PUSCH starts in the second slot of a subframe, the resource elements in the first slot of the subframe shall be counted in the PUSCH mapping but not used for transmission of PUSCH.

For a UE configured with autonomous uplink,

- if the UE indicates PUSCH ending symbol '1' in uplink control information, or *endingSymbolAUL* is set to '12', the resource elements in the last SC-FDMA symbol shall be counted in the PUSCH mapping but not used for transmission of PUSCH;

- if the UE indicates PUSCH starting symbol '1' in uplink control information, the resource elements in the first SC-FDMA symbol shall be counted in the PUSCH mapping but not used for transmission of PUSCH.

If uplink frequency-hopping is disabled or the resource blocks allocated for PUSCH transmission are not contiguous in frequency, the set of physical resource blocks to be used for transmission is given by  where  is obtained from the uplink scheduling grant as described in clause 8.1 in 3GPP TS 36.213 [4].

If uplink frequency-hopping with type 1 PUSCH hopping is enabled, the set of physical resource blocks to be used for transmission is given by clause 8.4.1 in 3GPP TS 36.213 [4].

If uplink frequency-hopping with predefined hopping pattern is enabled, the set of physical resource blocks to be used for transmission in slot  is given by the scheduling grant together with a predefined pattern according to



where  is obtained from the scheduling grant as described in clause 8.1 in 3GPP TS 36.213 [4]. The parameter *pusch-HoppingOffset*,, is provided by higher layers. The size  of each sub-band is given by,



where the number of sub-bands  is given by higher layers. The function  determines whether mirroring is used or not. The parameter *Hopping-mode* provided by higher layers determines if hopping is "inter-subframe" or "intra and inter-subframe".

The hopping function and the function are given by





where  and the pseudo-random sequence  is given by clause 7.2 and CURRENT\_TX\_NB indicates the transmission number for the transport block transmitted in slot as defined in [8]. The pseudo-random sequence generator shall be initialised with  for frame structure type 1 and  for frame structure type 2 at the start of each frame.

For BL/CE UEs, the PRB resources for PUSCH transmission in the first subframe are obtained from the DCI as described in clauses 5.3.3.1.10 and 5.3.3.1.11 in [3]. Each of the PUSCH codewords is transmitted with repetitions, where is the number of transport blocks defined in clause 8.0 of 3GPP TS 36.213 [4]. The PUSCH transmission spans consecutive subframes, including subframes that are not BL/CE UL subframes where the UE postpones the PUSCH transmission if .

- If uplink resource reservation is enabled for the UE as specified in [9], and the Resource reservation field in the DCI is set to 1, then in case of PUSCH transmission with  associated with C-RNTI or SPS C-RNTI using UE-specific MPDCCH search space including PUSCH transmission without a corresponding MPDCCH,

- In a subframe that is fully reserved as defined in clause 8.0 in [4], the PUSCH transmission is postponed until the next BL/CE uplink subframe that is not fully reserved.

- In a subframe that is partially reserved, the reserved SC-FDMA symbols shall be counted in the PUSCH mapping but not used for transmission of the PUSCH.

- In case the UE is a BL/CE UE configured with higher layer parameter *ce-PUSCH-SubPRB-Config-r15* or *subPRB-Allocation* in *PUR-PUSCH-Config*, the PUSCH transmission spans consecutive subframes including subframes that are not BL/CE UL subframes where the UE postpones the PUSCH transmission, where is the number of scheduled TBs if *ce-PUSCH-MultiTB-Config* is enabled and multiple TBs are scheduled, otherwise .

- For BL/CE UE in CEModeA,

- If PUSCH is transmitted using preconfigured uplink resources,

- PUSCH frequency hopping is enabled when the higher layer parameter *pur-PUSCH-FreqHopping* is set, otherwise frequency hopping is disabled.

- Else, if PUSCH scheduled by DCI format 6-0A is associated with PUR-RNTI,

- PUSCH frequency hopping is enabled when the higher layer parameter *pur-PUSCH-FreqHopping* is set and the frequency hopping flag in DCI format 6-0A indicates frequency hopping, otherwise frequency hopping is disabled.

- Else,

- PUSCH frequency hopping is enabled when the higher-layer parameter *pusch-HoppingConfig* is set and the frequency hopping flag in DCI format 6-0A indicates frequency hopping, otherwise frequency hopping is disabled.

- For BL/CE UE in CEModeB,

- If PUSCH is transmitted using preconfigured uplink resources,

- PUSCH frequency hopping is enabled when the higher layer parameter *pur-PUSCH-FreqHopping* is set, otherwise frequency hopping is disabled.

- Else, if PUSCH scheduled by DCI format 6-0B is associated with PUR-RNTI,

- PUSCH frequency hopping is enabled when the higher layer parameter *pur-PUSCH-FreqHopping* is set, otherwise frequency hopping is disabled.

- Else,

- PUSCH frequency hopping is enabled when the higher-layer parameter *pusch-HoppingConfig* is set, otherwise frequency hopping is disabled.

- If frequency hopping is not enabled for PUSCH, all PUSCH repetitions are located at the same PRB resources.

- If a BL/CE UE is configured with higher layer parameter *ce-PUSCH-FlexibleStartPRB-AllocConfig*, the UE is not expected to have the frequency hopping enabled for PUSCH with the resource allocation including the center PRB not belonging to any narrowband.

- If frequency hopping is enabled for PUSCH and the UE is not configured with CEModeA and higher layer parameter *ce-PUSCH-FlexibleStartPRB-AllocConfig*,

- PUSCH is transmitted in uplink subframe  within the  consecutive subframes using the same number of consecutive PRBs as in the previous subframe starting from the PRB resources of the narrowband  with the same RIV as that of narrowband . The narrowband  is defined as



where  is the absolute subframe number of the first UL subframe intended for carrying the PUSCH and  and  are cell-specific higher-layer parameters. For the  consecutive subframes, the UE shall not transmit PUSCH in subframe  if it is not a BL/CE UL subframe.

- If frequency hopping is enabled for PUSCH and the UE is configured with CEModeA and higher layer parameter *ce-PUSCH-FlexibleStartPRB-AllocConfig*,

- Except when the PUSCH resource allocation includes the center PRB not belonging to any narrowband, PUSCH is transmitted in uplink subframe  within the  consecutive subframes using the same number of consecutive PRBs as in the previous subframe, where is the narrowband index that starting PRB located in the absolute subframe number of the first UL subframe , defined as

- If 0 or with ,

- If with

where is the number of edge PRB(s) not belonging to narrowbands in one side of system bandwidth , is the number of narrowbands, the starting PRB index and the length of the allocated resources are defined in clause 8.1.1 of [4]. After hopping, the narrowband  in subframe  is defined as



where  and  are cell-specific higher-layer parameters. For the  consecutive subframes, the UE shall not transmit PUSCH in subframe  if it is not a BL/CE UL subframe. After hopping, the resource blocks have the same relative location of starting PRB in as in narrowband .

- If frequency hopping is enabled for PUSCH and the UE is configured with higher layer parameter *ce-PUSCH-FlexibleStartPRB-AllocConfig*,

- If a frequency hopping leads to a split resource allocation, where some PRB(s) is (are) on one edge and some PRB(s) is (are) on the other edge of the system bandwidth, the PUSCH transmission is dropped in that subframe.

- If a frequency hopping leads to a resource allocation, where some PRB(s) is (are) not belonging to any narrowband, the PUSCH transmission is dropped in that subframe.

For BL/CE UEs, for PUSCH transmission corresponding to the random access response grant and its retransmission, frequency hopping of the PUSCH is enabled when higher layer parameter *rar-HoppingConfig* is set. Further

- if PRACH CE level 0 or 1 is used for the last PRACH attempt,  is set to the higher layer parameter *interval-UlHoppingConfigCommonModeA*;

- if PRACH CE level 2 or 3 is used for the last PRACH attempt,  is set to the higher layer parameter *interval-UlHoppingConfigCommonModeB*.

For BL/CE UEs in CEModeB, for PUSCH transmission not associated with Temporary C-RNTI, for frame structure type 1, after a transmission duration of  time units (which may include subframes that are not BL/CE UL subframes), a gap of  time units shall be inserted, according to the UE capability *ue-CE-NeedULGaps*, as specified in 3GPP TS 36.331 [9]. BL/CE UL subframes within the gap of  time units shall be counted for the PUSCH resource mapping but not used for transmission of the PUSCH.

For BL/CE UEs, for PUSCH transmission associated with Temporary C-RNTI for frame structure type 1, and if PRACH CE level 2 or 3 is used for the last PRACH attempt, after a transmission duration of  time units (which may include subframes that are not BL/CE UL subframes), a gap of  time units shall be inserted. BL/CE UL subframes within the gap of  time units shall be counted for the PUSCH resource mapping but not used for transmission of the PUSCH.

For UEs configured with *PUSCH-EnhancementsConfig*, the number of PUSCH subframe repetitions  and the PRB resources for PUSCH transmission in the first subframe are obtained from the DCI as described in clause 5.3.3.1.1C in [3]. The PUSCH transmission spans  consecutive subframes, including DL subframes where the UE postpones the PUSCH transmission in the case of frame structure type 2. PUSCH frequency hopping is enabled when the higher-layer parameters *pusch-HoppingOffsetPUSCH-Enh* and *interval-ULHoppingPUSCH-Enh* are set and the frequency hopping flag in DCI format 0C indicates frequency hopping, otherwise frequency hopping is disabled. If frequency hopping is not enabled for PUSCH, the PUSCH repetitions are located at the same PRB resources as in the first subframe. If frequency hopping is enabled for PUSCH, PUSCH is transmitted in uplink subframe  within the  consecutive subframes using the PRB resources starting at PRB index 

where  is the absolute subframe number of the first UL subframe carrying the PUSCH and  is given by the higher-layer parameter *interval-ULHoppingPUSCH-Enh* and  is given by the higher-layer parameter *pusch-HoppingOffsetPUSCH-Enh*.

### 5.4.3 Mapping to physical resources

The block of complex-valued symbols  shall be multiplied with the amplitude scaling factor  in order to conform to the transmit power  specified in Clause 5.1.2.1 in 3GPP TS 36.213 [4], and mapped in sequence starting with  to resource elements. PUCCH uses one or more resource block in each of the two slots in a subframe. Within the physical resource block(s) used for transmission, the mapping of  to resource elements  on antenna port  and not used for transmission of reference signals shall be in increasing order of first , then  and finally the slot number, starting with the first slot in the subframe. The relation between the index  and the antenna port number  is given by Table 5.2.1-1.

For non-BL/CE UEs, except for PUCCH format 4, the physical resource blocks to be used for transmission of PUCCH in slot  are given by



For BL/CE UEs, PUCCH is transmitted with  repetitions. The PUCCH transmission spans  consecutive subframes, including subframes that are not BL/CE UL subframes where the UE postpones the PUCCH transmission if .

- The quantity  is given

- by the higher layer parameter *pucch-NumRepetitionCE-Format1* for PUCCH format 1/1a and *pucch-NumRepetitionCE-Format2* for PUCCH format 2/2a/2b, if configured. Otherwise

- by the higher-layer parameter *pucch-NumRepetitionCE-Msg4-Level0-r13, pucch-NumRepetitionCE-Msg4-Level1-r13, pucch-NumRepetitionCE-Msg4-Level2-r13* or *pucch-NumRepetitionCE-Msg4-Level3-r13*.

- If uplink resource reservation is enabled for the UE as specified in [9], then in case of PUCCH transmission with  associated with C-RNTI or SPS C-RNTI using UE-specific MPDCCH search space including PUCCH transmission without a corresponding MPDCCH,

- In a subframe that is fully reserved as defined in clause 8.0 in [4], the PUCCH transmission is postponed until the next BL/CE uplink subframe that is not fully reserved.

- In a subframe that is partially reserved, the reserved SC-FDMA symbols shall be counted in the PUCCH mapping but not used for transmission of the PUCCH.

The physical resource blocks to be used for transmission of PUCCH in subframe  within the  consecutive subframes are given by



where  is the absolute subframe number of the first uplink subframe intended for PUCCH.

The variable  depends on the PUCCH format.

- Formats 1, 1a and 1b:



- Formats 2, 2a and 2b:



- Format 3:



- Format 5 (non-BL/CE UEs only):



For non-BL/CE UEs, for PUCCH format 4, the physical resource blocks to be used for transmission of PUCCH in slot  are given by



where  is obtained from [4].

Mapping of modulation symbols for the physical uplink control channel for PUCCH formats 1 – 3 is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a, 1b, 3, 4 or 5 when there is one serving cell configured, the shortened PUCCH format shall be used where the last SC-FDMA symbol in the second slot of a subframe shall be left empty.

In case of guard period for narrowband or wideband retuning for BL/CE UEs, if an SC-FDMA symbol is left empty due to guard period, the SC-FDMA symbol shall be counted in the PUCCH mapping but not used for transmission of the PUCCH. The SC-FDMA symbol affected by the guard period can be the first SC-FDMA symbol in the first slot of a subframe and/or the last SC-FDMA symbol in the second slot of a subframe.



Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH formats 1 – 3 for non-BL/CE UEs.

##### 5.5.2.1.2 Mapping to physical resources

For each antenna port used for transmission of the PUSCH, the sequence  shall be multiplied with the amplitude scaling factor  and mapped in sequence starting with  to the resource blocks.

-  when either

- the higher-layer parameter *ul-DMRS-IFDMA* is set and the most recent uplink-related DCI contains the *Cyclic Shift Field mapping table for DMRS bit* field which is set to 1 to indicate the use of Table 5.5.2.1.1-3, or

- the *Cyclic Shift Field mapping table for DMRS bit* field is set to 1 in the most recent uplink-related DCI format 7 which indicates the use of Table 5.5.2.1.1-4, and

-  otherwise.

If higher-layer parameter *ul-DMRS-IFDMA* is set and the most recent uplink-related DCI contains the *Cyclic Shift Field mapping table for DMRS bit* field which is set to 1 to indicate the use of Table 5.5.2.1.1-3, the mapping to resource elements , with  for normal cyclic prefix and  for extended cyclic prefix, in the subframe shall be in increasing order of first  for all values of  satisfying ****, then the slot number. The quantity **** is given by Table 5.5.2.1.1-3 using the cyclic shift field in the most recent uplink-related DCI.

In case of slot-PUSCH, the mapping to resource elements , with  for normal cyclic prefix, in the slot of the subframe where slot-PUSCH is transmitted shall be in increasing order of first  for all values of , except if the *Cyclic Shift Field mapping table for DMRS bit* field is set to 1 in the most recent uplink-related DCI format 7, which indicates the use of Table 5.5.2.1.1-4. In this case the mapping to resource element shall be in increasing order of first  only for values of  satisfying **.**

In case of subslot-PUSCH, the mapping to resource elements , in the subframe shall be in increasing order of first  for all values of , except if the *Cyclic Shift Field mapping table for DMRS bit* field is set to 1 in the most recent uplink-related DCI format 7, which indicates the use of Table 5.5.2.1.1-4. In this case the mapping to resource element shall be in increasing order of first  only for values of  satisfying **.** The value of  depends on the uplink subslot number and the *DMRS-pattern* field in the most recent uplink-related DCI, according to Table 5.5.2.1.2-1, or according to Table 5.5.2.1.2-2 in case of semi-persistent scheduling of subslot-PUSCH (i.e. higher layer patameter *sps-ConfigUL-sTTI-r15* is configured, se 3GPP TS 36.331 [9]) and with a configured periodicity of 1 subslot (i.e. *semiPersistSchedIntervalUL-STTI-r15* set to *sTTI1*). In case of subslot-PUSCH and semi-persistent scheduling with a configured periodicity longer than 1 subslot, the mapping shall start at symbol  according to the first row of Table 5.5.2.1.2-2 (i.e. equivalent to a signalling of *DMRS-pattern* field set to '00'). In case no value of  is defined for the uplink subslot number, and in case no valid starting symbol index (see table 5.3.4-1), no reference signal is transmitted associated with the uplink-related DCI format.

Table 5.5.2.1.2-1: The quantity  for subslot-PUSCH

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *DMRS-pattern* field in uplink-related DCI format [3] | Uplink subslot number | | | | | |
| #0 | #1 | #2 | #3 | #4 | #5 |
| 00 | 0 | 3 | 5 | 0 | 2 | 4 |
| 01 | 2 | 4 | - | 1 | 3 | - |
| 10 | - | - | - | 2 | - | - |
| 11 | - | 5 | - | - | 4 | - |

Table 5.5.2.1.2-2: The quantity  for subslot-PUSCH for semi-persistent scheduling

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *DMRS-pattern* field in uplink-related DCI format [3] | Uplink subslot number | | | | | |
| #0 | #1 | #2 | #3 | #4 | #5 |
| 00 | 0 | 3 | 5 | 0 | 2 | 4 |
| 10 | 0 | 5 | 5 | 2 | 2 | 4 |

For all other cases, the set of physical resource blocks used in the mapping process and the relation between the index  and the antenna port number  shall be identical to the corresponding PUSCH transmission as defined in clause 5.3.4.

The mapping to resource elements , with , or with  according to Table 5.5.2.1.2-1 for subslot-PUSCH, for normal cyclic prefix and  for extended cyclic prefix, in the subframe shall be in increasing order of first, then the slot number, except for slot-PUSCH and subslot-PUSCH where the reference signal is only mapped to the slot where the slot-PUSCH/subslot-PUSCH is transmitted). No DM-RS shall be transmitted in UpPTS if *dmrsLess-UpPts* is set to true.

For BL/CE UEs, if uplink resource reservation is enabled for the UE as specified in [9], and the Resource reservation field in the DCI is set to 1, then in case of PUSCH transmission with  associated with C-RNTI or SPS C-RNTI using UE-specific MPDCCH search space including PUSCH transmission without a corresponding MPDCCH,

- In a subframe that is fully reserved as defined in clause 8.0 in [4], the demodulation reference signal transmission is postponed until the next BL/CE uplink subframe that is not fully reserved.

- In a subframe that is partially reserved, the demodulation reference signal transmission in a SC-FDMA symbol that is reserved is dropped.

##### 5.5.2.1A.4 Mapping to physical resources

The sequence  shall be multiplied with the amplitude scaling factor  and mapped in sequence starting with  to the sub-carriers.

The set of sub-carriers used in the mapping process shall be identical to the corresponding PUSCH transmissions using sub-PRB allocations for BL/CE UEs as defined in clause 5.3.4.

The mapping to resource elements  shall be in increasing order of first, then , and finally the slot number. The value of the symbol index  in a slot is 3.

For BL/CE UEs, if uplink resource reservation is enabled for the UE as specified in [9], and the Resource reservation field in the DCI is set to 1, then in case of PUSCH transmission with  associated with C-RNTI or SPS C-RNTI using UE-specific MPDCCH search space including PUSCH transmission without a corresponding MPDCCH,

- In a subframe that is fully reserved as defined in clause 8.0 in [4], the demodulation reference signal transmission is postponed until the next BL/CE uplink subframe that is not fully reserved.

- In a subframe that is partially reserved, the demodulation reference signal transmission in a SC-FDMA symbol that is reserved is dropped.

##### 5.5.2.2.2 Mapping to physical resources

The sequence  shall be multiplied with the amplitude scaling factor  and mapped in sequence starting with  to resource elements on antenna port . The mapping shall be in increasing order of first, then  and finally the slot number. The set of values for  and the relation between the index  and the antenna port number  shall be identical to the values used for the corresponding PUCCH transmission. The values of the symbol index  in a slot are given by Table 5.5.2.2.2-1.

Table 5.5.2.2.2-1: Demodulation reference signal location for different PUCCH formats.

|  |  |  |
| --- | --- | --- |
| PUCCH format | Set of values for | |
| Normal cyclic prefix | Extended cyclic prefix |
| 1, 1a, 1b | 2, 3, 4 | 2, 3 |
| 2, 3 | 1, 5 | 3 |
| 2a, 2b | 1, 5 | N/A |
| 4,5 | 3 | 2 |

For BL/CE UEs, if uplink resource reservation is enabled for the UE as specified in [9], then in case of PUCCH transmission with  associated with C-RNTI or SPS C-RNTI using UE-specific MPDCCH search space including PUCCH transmission without a corresponding MPDCCH,

- In a subframe that is fully reserved as defined in clause 8.0 in [4], the demodulation reference signal transmission is postponed until the next BL/CE uplink subframe that is not fully reserved.

- In a subframe that is partially reserved, the demodulation reference signal transmission in a SC-FDMA symbol that is reserved is dropped.

### 6.4.1 Physical downlink shared channel for BL/CE UEs

For BL/CE UEs, the following additions and exceptions hold in addition to those in clause 6.4:

- The maximum number of allocatable PRBs for PDSCH is restricted as follows:

- If the PDSCH is associated with C-RNTI or SPS C-RNTI and the higher layer parameter *ce-pdsch-maxBandwidth-config* is set,

- if the higher layer parameter *ce-pdsch-maxBandwidth-config* is set to 20 MHz, the maximum number of allocatable PRBs for PDSCH is 96 PRBs restricted to the narrowbands defined in clause 6.2.7;

- if the higher layer parameter *ce-pdsch-maxBandwidth-config* is set to 5 MHz, the maximum number of allocatable PRBs for PDSCH is 24 PRBs restricted to no more than four of the narrowbands defined in clause 6.2.7.

- If the PDSCH is associated with G-RNTI and the higher layer parameter *pdsch-MaxBandwidth-SC-MTCH* is set to 24 PRBs, the maximum number of allocatable PRBs for PDSCH is 24 PRBs restricted to no more than four of the narrowbands defined in clause 6.2.7.

- For all other cases, the maximum number of allocatable PRBs for PDSCH is 6 PRBs restricted to one of the narrowbands defined in clause 6.2.7.

- Resource elements occupied by CSI reference signals shall be counted in the PDSCH mapping but not used for transmission of the PDSCH.

- Resource elements belonging to synchronization signals, the core part of PBCH, PBCH repetitions, or resource elements reserved for reference signals in the mapping operation of PBCH but not used for transmission of reference signals, shall be counted in the PDSCH mapping but not used for transmission of the PDSCH.

- PRB pairs occupied by RSS shall be counted in the PDSCH mapping but not used for transmission of the PDSCH.

- For BL/CE UEs in CEModeB configured in transmission mode 9, in MBSFN subframe(s), resource elements that correspond to the positions of cell-specific reference signals as in subframe #0 shall not be counted in the PDSCH mapping and not used for transmission of the PDSCH.

- Resource elements belonging to PRBs in which PRS is transmitted (including PRS muted subframes) shall be counted in the PDSCH mapping but not used for transmission of the PDSCH.

- If the higher layer parameter *ce-punctured-subcarriers-DL* is configured, and the DCI associated with the PDSCH uses C-RNTI or SPS C-RNTI, and transmit diversity according to clause 6.3.4.3 is used,

- In the mapping to resource elements, when the complex-valued symbols  and , where  is an even number, are mapped to resource elements  and  in the same OFDM symbol with , then if *ce-punctured-subcarriers-DL* indicates that any of  and  shall be counted but not used for transmission, the UE shall assume that both  and  are counted but not used for transmission.

- If PDSCH transmission in the LTE control region is configured by higher layer parameter *transmissionInControlChRegion*, after the initial mapping of the PDSCH to resource elements starting from in the first slot to the last OFDM symbol available for downlink transmission in the subframe has been performed, the mapping shall continue with resource elements not reserved for cell-specific reference signals in increasing order of first the index over the assigned physical resource blocks and then the index starting from in the first slot to in the first slot, where is given by clause 7.1.6.4 of 3GPP TS 36.213 [4].

For BL/CE UEs, if the PDSCH is not carrying SIB1-BR the PRB resources for PDSCH transmission in the first subframe are obtained from the DCI as described in clauses 5.3.3.1.12, 5.3.3.1.13, and 5.5.1.3.14 in [3], or provided by higher layers. Each of the PDSCH codewords is transmitted with  repetitions, where is the number of transport blocks defined in clause 7.1.11 of 3GPP TS 36.213 [4]. The PDSCH transmission spans consecutive subframes, including subframes that are not BL/CE DL subframes where the the PDSCH transmission is postponed.

- If downlink resource reservation is enabled for the UE as specified in [9], and the Resource reservation field in the DCI is set to 1, then in case of PDSCH transmission associated with C-RNTI or SPS C-RNTI using UE-specific MPDCCH search space including PDSCH transmission without a corresponding MPDCCH,

- In a subframe that is fully reserved as defined in clause 7.1 in [4], the PDSCH transmission is postponed until the next BL/CE downlink subframe that is not fully reserved.

- In a subframe that is partially reserved, the reserved resource elements shall be counted in the PDSCH mapping but not used for transmission of the PDSCH.

- If frequency hopping is not enabled for PDSCH, all PDSCH repetitions are located at the same PRB resources, and

- if frequency hopping is enabled for PDSCH, the PDSCH shall be transmitted in subframe  within the  consecutive downlink subframes using the PRB resources of the narrowband  with the same RIV as that of narrowband . The narrowband  is defined as



where  is the absolute subframe number of the first downlink subframe intended for PDSCH and ,  and  are cell-specific higher-layer parameters. For PDSCH carrying SI other than SIB1-BR and for PDSCH associated with P-RNTI, if *interval-DlHoppingConfigCommonModeB* is signalled in SIB1-BR, then the frequency hopping granularity  is set to *interval-DlHoppingConfigCommonModeB*; otherwise,  is set to *interval-DlHoppingConfigCommonModeA* signalled in SIB1-BR.

For BL/CE UE in CEModeA, frequency hopping of PDSCH associated with C-RNTI or SPS C-RNTI is enabled when higher layer parameter *mpdcch-pdsch-HoppingConfig* is set and the frequency hopping flag in DCI format 6-1A indicates frequency hopping, otherwise, frequency hopping of is not enabled. For BL/CE UE in CEModeB, frequency hopping of PDSCH associated with C-RNTI or SPS C-RNTI is enabled when higher layer parameter *mpdcch-pdsch-HoppingConfig* is set, otherwise, frequency hopping of is not enabled.

The UE shall not expect PDSCH in subframe  if it is not a BL/CE DL subframe.

For BL/CE UEs, if the PDSCH carries SIB1-BR, the PDSCH transmission is repeated periodically in every period of 8 radio frames, where a period starts with a radio frame with  where ** is the system frame number. The PDSCH is transmitted  times in each period of 8 frames, Let  be the set of narrowbands, excluding narrowbands overlapping with the 72 center subcarriers for , and ordered in increasing order of narrowband index. The PDSCH transmission cycles through the set  of narrowbands in increasing order of **, starting with ** for the first subframe, according to

**

where  is the number of narrowbands in the set .

The set of frames and subframes used for SIB1-BR transmission in each period are given by Tables 6.4.1-1 and 6.4.1-2.

Table 6.4.1-1: The set of frames and subframes for SIB1-BR for .

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | Frame structure type 1 | | Frame structure type 2 | |
|  |  |  |  |
| 4 | 0 | 0 | 4 | 1 | 5 |
| 1 | 1 | 4 | 1 | 5 |

Table 6.4.1-2: The set of frames and subframes for SIB1-BR for .

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | Frame structure type 1 | | Frame structure type 2 | |
|  |  |  |  |
| 4 | 0 | 0 | 4 | 1 | 5 |
| 1 | 1 | 4 | 1 | 0 |
| 8 | 0 | 0, 1 | 4 | 0, 1 | 5 |
| 1 | 0, 1 | 9 | 0, 1 | 0 |
| 16 | 0 | 0, 1 | 4, 9 | 0, 1 | 0, 5 |
| 1 | 0, 1 | 0, 9 | 0, 1 | 0, 5 |

BL/CE UEs may assume the same precoding matrix being used for a PRB across a block of  consecutive subframes when UE-specific reference signals are transmitted together with the PDSCH, where the subframe number of the first subframe in each block of  consecutive subframes, denoted as , satisfies .

For PDSCH transmission associated with SI-RNTI or P-RNTI to BL/CE UEs, frequency hopping of the PDSCH is enabled when higher layer parameter *si-HoppingConfigCommon* is set.

For PDSCH transmission associated with PUR-RNTI to BL/CE UEs using UE-specific MPDCCH search space, frequency hopping of the PDSCH is enabled when higher layer parameter *pur-PDSCH-FreqHopping* is set.

For PDSCH transmission associated with RA-RNTI or temporary C-RNTI to BL/CE UEs, frequency hopping of the PDSCH is enabled when higher layer parameter *rar-HoppingConfig* is set. Further

- if PRACH CE level 0 or 1 is used for the last PRACH attempt,  is set to the higher layer parameter *interval-DlHoppingConfigCommonModeA*;

- if PRACH CE level 2 or 3 is used for the last PRACH attempt,  is set to the higher layer parameter *interval-DlHoppingConfigCommonModeB*.

For PDSCH transmission associated with SC-RNTI to BL/CE UEs, frequency hopping of the PDSCH is enabled when higher layer parameter *mpdcch-pdsch-HoppingConfig-SC-MCCH* is set. Further

- if *mpdcch-pdsch-HoppingConfig-SC-MCCH* is set to CEModeA,  is set to the higher layer parameter *interval-DlHoppingConfigCommonModeA*;

- if *mpdcch-pdsch-HoppingConfig-SC-MCCH* is set to CEModeB,  is set to the higher layer parameter *interval-DlHoppingConfigCommonModeB.*

For PDSCH transmission associated with G-RNTI to BL/CE UEs,

- if the higher layer parameter *mpdcch-pdsch-CEmodeConfig-SC-MTCH* is set to CEModeA,

- if the higher layer parameter *mpdcch-pdsch-HoppingConfig-SC-MTCH* is set and the frequency hopping flag in DCI format 6-1A indicates frequency hopping, then frequency hopping of the PDSCH is enabled and  is set to the higher layer parameter *interval-DlHoppingConfigCommonModeA*, otherwise frequency hopping is not enabled;

- if the higher layer parameter *mpdcch-pdsch-CEmodeConfig-SC-MTCH* is set to CEModeB,

- if the higher layer parameter *mpdcch-pdsch-HoppingConfig-SC-MTCH* is set, then frequency hopping of the PDSCH is enabled and  is set to the higher layer parameter *interval-DlHoppingConfigCommonModeB*, otherwise frequency hopping is not enabled*.*

### 6.8B.5 Mapping to resource elements

Mapping to resource elements shall be done according to Clause 6.8A.5 with the following exceptions:

- The term EPDCCH shall be replaced by MPDCCH.

- The mapping shall be repeated across each of the  BL/CE DL subframes.

-  is the number of ECCEs used for this MPDCCH in the first of the  subframes.

- For an MPDCCH associated with a 2+4 PRB set as defined in [4], the mapping to resource elements  on antenna port  shall be in increasing order of first the index  and then the index over the 6 PRBs for MPDCCH format 5 and over the 2 or 4 PRBs for the other MPDCCH formats.

- For localized transmission and MPDCCH format 5, the single antenna port  to use is given by Table 6.8A.5-1 with



where  equals the C-RNTI.

- Resource elements occupied by CSI reference signals shall be counted in the MPDCCH mapping but not used for transmission of the MPDCCH.

- PRB pairs occupied by RSS shall be counted in the MPDCCH mapping but not used for transmission of the MPDCCH.

- Resource elements belonging to PRBs in which PRS is transmitted (including PRS muted subframes) shall be counted in the MPDCCH mapping but not used for transmission of the MPDCCH.

- A BL/CE UE not configured with higher layer parameter *ce-pdsch-maxBandwidth-config* and not configured with higher layer parameter *ce-PDSCH-FlexibleStartPRB-AllocConfig* may assume there is no MPDCCH transmission which uses overlapping sets of subframes as PDSCH transmissions to that UE, where the MPDCCH is located at a different narrowband than the PDSCH.

- A BL/CE UE configured with higher layer parameter *ce-pdsch-maxBandwidth-config* may assume that there is no MPDCCH transmission which uses overlapping sets of subframes as PDSCH transmissions to that UE, where the MPDCCH transmission and PDSCH transmission in any of the overlapping subframes span a PRB region larger than *X* contiguous PRBs where *X*=25 if *ce-pdsch-maxBandwidth-config* is set to 5 MHz and *X*=100 if *ce-pdsch-maxBandwidth-config* is set to 20 MHz.

- A BL/CE UE configured with higher layer parameter *ce-PDSCH-FlexibleStartPRB-AllocConfig* may assume there is no MPDCCH transmission in MPDCCH candidates not fully contained within the tuning narrowband defined for PDSCH in Clause 6.2.8.

- For BL/CE UEs in CEModeB, in MBSFN subframe(s), resource elements that correspond to the positions of cell-specific reference signals as in subframe #0 shall not be counted in the MPDCCH mapping and not used for transmission of the MPDCCH.

- Resource elements belonging to synchronization signals, the core part of PBCH, PBCH repetitions, or resource elements reserved for reference signals in the mapping operation of PBCH but not used for transmission of reference signals, shall be counted in the MPDCCH mapping but not used for transmission of the MPDCCH.

- If MPDCCH transmission in the LTE control region is configured by the higher layer parameter *transmissionInControlChRegion*,

- For frame structure type 1 and frame structure type 2 except special subframe configuration 9 or 10,

- Symbols used for transmission of MPDCCH or demodulation signals associated with MPDCCH and mapped to resource element in the second slot, where , shall additionally be mapped to resource element in the first slot.

- For frame structure type 2 and special subframe configuration 9 or 10,

- Symbols used for transmission of MPDCCH or demodulation signals associated with MPDCCH and mapped to resource element in the first slot, where , shall additionally be mapped to resource element in the first slot, if resource element in the first slot is not used for cell-specific reference signals.

- In the subframes where an MPDCCH or its associated PDSCH is transmitted in response to a physical random access transmission initiated by a PDCCH order, the UE shall receive the MPDCCH or its associated PDSCH, and assume no other UE-specific reception is needed.

- For MPDCCH transmission associated with C-RNTI or TPC-PUCCH-RNTI or TPC-PUSCH-RNTI or SPS C-RNTI that are not configured to use the Type2-MPDCCH common search space, frequency hopping of the MPDCCH is enabled when higher layer parameter *mpdcch-pdsch-HoppingConfig* is set.

- For MPDCCH transmission associated with PUR-RNTI using UE-specific MPDCCH search space, frequency hopping of the MPDCCH is enabled when *mpdcch-FreqHopping* inhigher layer parameter *PUR-MPDCCH-Config* is set.

- For MPDCCH transmission associated with Type2-MPDCCH common search space, frequency hopping of the MPDCCH is enabled when higher layer parameter *rar-HoppingConfig* is set. Further

- if PRACH CE level 0 or 1 is used for the last PRACH attempt,  is set to the higher layer parameter *interval-DlHoppingConfigCommonModeA*;

- if PRACH CE level 2 or 3 is used for the last PRACH attempt,  is set to the higher layer parameter *interval-DlHoppingConfigCommonModeB*.

- For MPDCCH transmission associated with SC-RNTI, frequency hopping of the MPDCCH is enabled when higher layer parameter *mpdcch-pdsch-HoppingConfig-SC-MCCH* is set. Further

- if *mpdcch-pdsch-HoppingConfig-SC-MCCH* is set to CEModeA,  is set to the higher layer parameter *interval-DlHoppingConfigCommonModeA*;

- if *mpdcch-pdsch-HoppingConfig-SC-MCCH* is set to CEModeB,  is set to the higher layer parameter *interval-DlHoppingConfigCommonModeB.*

- For MPDCCH transmission associated with G-RNTI, frequency hopping of the MPDCCH is enabled when higher layer parameter *mpdcch-pdsch-HoppingConfig-SC-MTCH* is set. Further

- if *mpdcch-pdsch-CEmodeConfig-SC-MTCH* is set to CEModeA,  is set to the higher layer parameter *interval-DlHoppingConfigCommonModeA*;

- if *mpdcch-pdsch-CEmodeConfig-SC-MTCH* is set to CEModeB,  is set to the higher layer parameter *interval-DlHoppingConfigCommonModeB.*

- The narrowband  for MPDCCH transmission in the first subframe of MPDCCH search space is provided by higher layers. Starting subframe configuration of a search space where UE monitors an MPDCCH is also provided by higher layers. The MPDCCH search space uses  subframes, spanning  consecutive subframes, including subframes that are not BL/CE DL subframes where the MPDCCH transmission is postponed.

- If downlink resource reservation is enabled for the UE as specified in [9], then in case of MPDCCH transmission associated with C-RNTI or SPS C-RNTI using UE-specific MPDCCH search space,

- In a subframe that is fully reserved as defined in clause 7.1 in [4], the MPDCCH transmission is postponed until the next BL/CE downlink subframe that is not fully reserved.

- In a subframe that is partially reserved, the reserved resource elements shall be counted in the MPDCCH mapping but not used for transmission of the MPDCCH.

- If frequency hopping is not enabled for MPDCCH, the repetitions of an MPDCCH candidate are located at the same PRB resources in the same narrowband , and

- if frequency hopping is enabled for MPDCCH, an MPDCCH candidate shall be transmitted in absolute subframe  using the same PRB resources within each narrowband 



where  is the absolute subframe number of the first downlink subframe of MPDCCH search space, and ,  and  are cell-specific higher-layer parameters. The UE shall not expect MPDCCH transmission in absolute subframe  if it is not a BL/CE DL subframe.

- The UE may assume the same precoding matrix being used for a PRB across a block of  consecutive subframes for MPDCCH, where the subframe number of the first subframe in each block of  consecutive subframes, denoted as , satisfies .

- If *crs-ChEstMPDCCH-ConfigCommon* or *crs-ChEstMPDCCH-ConfigDedicated* is configured by higher layers, the relation between the MPDCCH and CRS antenna ports is defined as follows:

- When one CRS port is configured by the eNB, the antenna port(s) used for MPDCCH transmission are equivalent to CRS port 0.

- For distributed transmission and when two CRS ports are configured by the eNB, the relation between the symbols transmitted on the antenna ports used for MPDCCH transmission and CRS ports 0 – 1 is defined by the precoder matrix for single-layer transmission in Table 6.3.4.2.3-1 using codebook index for antenna port 107 and codebook index for antenna port 109.

- For distributed transmission and when four CRS ports are configured by the eNB, in absolute subframe and resource block index within one or two MPDCCH PRB sets where UE monitors an MPDCCH, the relation between the symbols transmitted on the antenna ports used for MPDCCH transmission and CRS ports 0 – 3 is defined by the precoder matrix for single-layer transmission in Table 6.3.4.2.3-2 using codebook index for antenna port 107 and codebook index for antenna port 109, where

- For localized transmission, when two CRS ports are configured by the eNB and predefined mapping type is used, in absolute subframe and resource block index within one or two MPDCCH PRB sets where UE monitors an MPDCCH, the relation between the symbols transmitted on the antenna port used for MPDCCH transmission and CRS ports 0 – 1 is defined by the precoder matrix for single-layer transmission in Table 6.3.4.2.3-1, with codebook index , where

- For localized transmission, when four CRS ports are configured by the eNB and predefined mapping type is used, in absolute subframe and resource block index within one or two MPDCCH PRB sets where UE monitors an MPDCCH, the relation between the symbols transmitted on the antenna port used for MPDCCH transmission and CRS ports 0 – 3 is given by the precoder matrix for single-layer transmission in Table 6.3.4.2.3-2 using codebook index where

- For localized transmission and when CSI-based or reciprocity-based mapping type is used, the relation between the symbols transmitted on the antenna port used for MPDCCH transmission and the CRS ports is given in [4]. When it is indicated in [4] that the antenna port is changed for an MPDCCH candidate with aggregation level 2, the antenna port shall be replaced by the antenna port determined for an MPDCCH candidate with aggregation level 4 in the same search space.

- NOTE: , with for and otherwise, where the ordering of PRBs within the PRB set(s) is in increasing order of PRB index.

The UE may assume that an MPDCCH associated with the P-RNTI is transmitted on the set  of narrowbands where  is defined in Clause 6.4.1. For a UE monitoring an MPDCCH associated with the P-RNTI, the first MPDCCH narrowband is given by  where ,  is the Paging Narrowband (PN) obtained according to [10], and  is the higher-layer parameter *paging-narrowBands*.

- If the higher-layer parameter *si-HoppingConfigCommon* disables frequency hopping for an MPDCCH associated with P-RNTI, each MPDCCH candidate shall be located in the same PRB in narrowband  where .

- If the higher-layer parameter *si-HoppingConfigCommon* enables frequency hopping for an MPDCCH with P-RNTI, an MPDCCH candidate shall be located in narrowband  in absolute subframe ** using the same PRB resources within each narrowband  where





where  is the absolute subframe number of the first downlink subframe of MPDCCH search space according to locations of paging opportunity subframes, and ,  and  are cell-specific higher-layer parameters. For MPDCCH associated with P-RNTI, if *interval-DlHoppingConfigCommonModeB* is signalled in SIB1-BR, then the frequency hopping granularity  is set to *interval-DlHoppingConfigCommonModeB*; otherwise,  is set to *interval-DlHoppingConfigCommonModeA* signalled in SIB1-BR.

The UE shall not expect MPDCCH transmission in absolute subframe  if it is not a BL/CE DL subframe.

#### 6.10.3.2 Mapping to resource elements

For antenna port 5, in a physical resource block with frequency-domain index  assigned for the corresponding PDSCH transmission, the reference signal sequence  shall be mapped to complex-valued modulation symbols  with  in a subframe according to:

Normal cyclic prefix:





Extended cyclic prefix:





where  is the counter of UE-specific reference signal resource elements within a respective OFDM symbol of the PDSCH transmission.

The cell-specific frequency shift is given by .

The mapping shall be in increasing order of the frequency-domain index  of the physical resource blocks assigned for the corresponding PDSCH transmission. The quantity  denotes the assigned bandwidth in resource blocks of the corresponding PDSCH transmission.

Figure 6.10.3.2-1 illustrates the resource elements used for UE-specific reference signals for normal cyclic prefix for antenna port 5.

Figure 6.10.3.2-2 illustrates the resource elements used for UE-specific reference signals for extended cyclic prefix for antenna port 5.

The notation  is used to denote a resource element used for reference signal transmission on antenna port.



Figure 6.10.3.2-1: Mapping of UE-specific reference signals, antenna port 5 (normal cyclic prefix)



Figure 6.10.3.2-2: Mapping of UE-specific reference signals, antenna port 5 (extended cyclic prefix)

For antenna ports , , , , , , or the antenna ports indicated in Table 6.3.4.4-1 in a physical resource block with frequency-domain index  assigned for the corresponding PDSCH transmission, a part of the reference signal sequence  shall be mapped to complex-valued modulation symbols  in a subframe according to

Normal cyclic prefix:



where



The sequence  is given by Table 6.10.3.2-1.

Table 6.10.3.2-1: The sequence  for normal cyclic prefix

|  |  |
| --- | --- |
| Antenna port |  |
| 7 |  |
| 8 |  |
| 9 |  |
| 10 |  |
| 11 |  |
| 12 |  |
| 13 |  |
| 14 |  |

Extended cyclic prefix:



where



The sequence  is given by Table 6.10.3.2-2.

Table 6.10.3.2-2: The sequence  for extended cyclic prefix and for slot/subslot-PDSCH

|  |  |
| --- | --- |
| Antenna port |  |
| 7 |  |
| 8 |  |
| 9 |  |
| 10 |  |

For extended cyclic prefix, UE-specific reference signals are not supported on antenna ports 9 to 14.

For slot-PDSCH transmission, the baseline pattern (see ‘Baseline’ in Figure 6.10.3.2-2A) of UE-specific reference signals is defined as follows. It is applied in MBSFN subframes.



where

- 

- 

- 

-

- 

- 

and

- if the slot where the PDSCH is transmitted in () fulfils 

- if the slot where the PDSCH is transmitted in () fulfils 

The sequence  is given by Table 6.10.3.2-2.

For slot-PDSCH transmission in normal subframes,is generated as for the baseline slot-PDSCH UE-specific reference signal pattern for the same values of , while  is given by and depends on the cell-specific frequency shift as follows (see ‘v0’, ‘v1’ and ‘v2’ in Figure 6.10.3.2-2A for , , and , respectively):

- For , ,

- For , ,

- For , .



Figure 6.10.3.2-2A: Mapping of UE-specific reference signals for slot-PDSCH, antenna ports 7, 8, 9 and 10 (normal cyclic prefix)

For subslot-PDSCH transmission, the baseline pattern (see ‘Baseline’ in Figure 6.10.3.2-2B) of UE-specific reference signals is defined as follows. It is applied if the presence of UE-specific reference signals is indicated in the DCI associated with the subslot-PDSCH (see *DMRS position indicator* field in 3GPP TS 36.212 [3]), and in downlink subslots where the baseline pattern, including all the REs associated with  if the parameter *maxLayersMIMO-STTI* is configured with 2 layers, or  if the parameter *maxLayersMIMO-STTI*  is configured with 4 layers, has no overlapping resource element with CRS and no overlapping resource element with configured zero-power and non-zero-power CSI reference signals:



where



The sequence  is given by Table 6.10.3.2-2.For subslot-PDSCH transmission in normal subframes, in downlink subslots where the baseline pattern, including all the REs associated with  if the parameter *maxLayersMIMO-STTI* is configured with 2 layers, or  if the parameter *maxLayersMIMO-STTI*  is configured with 4 layers, has overlapping resource elements with configured zero-power or non-zero-power CSI reference signals or has overlapping resource elements with CRS, if the presence of UE-specific reference signals is indicated in the DCI associated (see *DMRS position indicator* field in 3GPP TS 36.212 [3]) with the subslot-PDSCH, a shifted pattern of UE-specific reference signals is applied. In the shifted pattern,is generated as for the baseline subslot-PDSCH UE-specific reference signal pattern for the same value of , while  is given by and depends on the cell-specific frequency shift as follows (see also ‘v0’,’v1’ and ‘v2’ in Figure 6.10.3.2-2B for , , and , respectively):

- For , ,

- For , ,

- For , ,

For subslot-PDSCH transmission in MBSFN subframes, in downlink subslots where the baseline pattern, including all the REs associated with  if the parameter *maxLayersMIMO-STTI* is configured with 2 layers, or  if the parameter *maxLayersMIMO-STTI*  is configured with 4 layers, has overlapping resource elements with configured zero-power or non-zero-power CSI reference signals, if the presence of UE-specific reference signals is indicated in the DCI associated (see *DMRS position indicator* field in 3GPP TS 36.212 [3]) with the subslot-PDSCH, the shifted pattern of UE-specific reference signals for , as defined above, is applied (see ‘v0’ in Figure 6.10.3.2-2B for ).



Figure 6.10.3.2-2B: Mapping of UE-specific reference signals for subslot-PDSCH, antenna ports 7, 8, 9 and 10 (normal cyclic prefix)

Resource elements  used for transmission of UE-specific reference signals to one UE on any of the antenna ports in the set , where  or  shall

- not be used for transmission of PDSCH on any antenna port in the same slot, and

- not be used for UE-specific reference signals to the same UE on any antenna port other than those in  in the same slot.

Figure 6.10.3.2-3 illustrates the resource elements used for UE-specific reference signals for normal cyclic prefix for antenna ports 7, 8, 9 and 10. Figure 6.10.3.2-4 illustrates the resource elements used for UE-specific reference signals for extended cyclic prefix for antenna ports 7, 8.

For BL/CE UEs, if downlink resource reservation is enabled for the UE as specified in [9], and the Resource reservation field in the DCI is set to 1, then in case of PDSCH transmission associated with C-RNTI or SPS C-RNTI using UE-specific MPDCCH search space including PDSCH transmission without a corresponding MPDCCH,

- If all OFDM symbols in a PRB are reserved, the demodulation reference signal transmission in that PRB is dropped.



Figure 6.10.3.2-3: Mapping of UE-specific reference signals, antenna ports 7, 8, 9 and 10 (normal cyclic prefix)



Figure 6.10.3.2-4: Mapping of UE-specific reference signals, antenna ports 7 and 8 (extended cyclic prefix)

#### 6.10.3A.2 Mapping to resource elements

For the antenna port  in a physical resource block  assigned for the associated EPDCCH/MPDCCH, a part of the reference signal sequence  shall be mapped to complex-valued modulation symbols  in a subframe according to

Normal cyclic prefix:



where



The sequence  is given by Table 6.10.3A.2-1.

Table 6.10.3A.2-1: The sequence  for normal cyclic prefix

|  |  |
| --- | --- |
| Antenna port |  |
| 107 |  |
| 108 |  |
| 109 |  |
| 110 |  |

Extended cyclic prefix:



where



The sequence  is given by Table 6.10.3A.2-2.

Table 6.10.3A.2-2: The sequence  for extended cyclic prefix

|  |  |
| --- | --- |
| Antenna port |  |
| 107 |  |
| 108 |  |

For extended cyclic prefix, demodulation reference signals are not supported on antenna ports 109 to 110.

For the antenna port  in a physical resource block  assigned for the SPDCCH, a part of the reference signal sequence  shall be mapped to complex-valued modulation symbols  in a subframe according to the procedure used for UE-specific reference signals associated with subslot-PDSCH on antenna port described in section 6.10.3.2 with the following amendments:

- for slot-SPDCCH, ,

- for slot-SPDCCH in MBSFN subframes, the procedure used for the baseline pattern of UE-specific reference signals associated with subslot-PDSCH is applied

- for slot-SPDCCH in normal subframes, the procedure used for the shifted pattern of UE-specific reference signals associated with subslot-PDSCH depending on the cell-specific frequency shift is applied.

Resource elements  used for transmission of demodulation reference signals to one UE on any of the antenna ports in the set , where  or  shall

- not be used for transmission of EPDCCH/MPDCCH on any antenna port in the same slot, and

- not be used for demodulation reference signals to the same UE on any antenna port other than those in  in the same slot.

Replacing antenna port numbers 7 – 10 by 107 – 110 in Figure 6.10.3.2-3 provides an illustration of the resource elements used for demodulation reference signals associated with EPDCCH/MPDCCH for normal cyclic prefix. Replacing antenna port numbers 7 – 8 by 107 – 108 in Figure 6.10.3.2-4 provides an illustration of the resource elements used for demodulation reference signals associated with EPDCCH/MPDCCH for extended cyclic prefix.

For frame structure type 3, for EPDCCH in a subframe with the same duration as the DwPTS duration of a special subframe configuration, the mapping of the demodulation reference signals to the resource elements is the same as that for the corresponding special subframe configuration.

For BL/CE UEs, if downlink resource reservation is enabled for the UE as specified in [9], then in case of MPDCCH transmission associated with C-RNTI or SPS C-RNTI using UE-specific MPDCCH search space,

- If all OFDM symbols in a PRB are reserved, the demodulation reference signal transmission in that PRB is dropped.