**3GPP TSG RAN WG1 #107-e** **R1-210xxxx**

**e-Meeting, November 11th – 19th, 2021**

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| *CR-Form-v12.0* | | | | | | | | |
| **DRAFT CHANGE REQUEST** | | | | | | | | |
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|  | **38.213** | **CR** |  | **rev** |  | **Current version:** | **16.7.0** |  |
|  | | | | | | | | |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

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| ***Title:*** | Introduction of coverage enhancements in NR | | | | | | | | | |
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| ***Source to WG:*** | Samsung | | | | | | | | | |
| ***Source to TSG:*** |  | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_cov\_enh-Core | | | | |  | ***Date:*** | | | 2021-11-29 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | B |  | | | | | ***Release:*** | | | Rel-17 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) Rel-12 (Release 12)* *Rel-13 (Release 13) Rel-14 (Release 14) Rel-15 (Release 15) Rel-16 (Release 16)* | |
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| ***Reason for change:*** | | Introduction of coverage enhancement in NR. | | | | | | | | |
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| ***Summary of change:*** | | Add descriptions for application of TPC commands for repetitions with DM-RS bundling, for Msg3 PUSCH repetitions, and for enhancements to PUCCH repetitions. | | | | | | | | |
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| ***Consequences if not approved:*** | | Incomplete support for coverage enhancements in NR. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 7.1.1, 7.2.1, 8.3, 9.2.6 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | | **X** |  | Other core specifications | | | | TS 38.211, TS 38.212, TS 38.214 | | |
| ***affected:*** | |  | **X** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

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

### 7.1.1 UE behaviour

If a UE transmits a PUSCH on active UL BWP  of carrier  of serving cell  using parameter set configuration with index  and PUSCH power control adjustment state with index , the UE determines the PUSCH transmission power  in PUSCH transmission occasion  as

 [dBm]

where,

- is the UE configured maximum output power defined in [8-1, TS 38.101-1], [8-2, TS38.101-2] and [8-3, TS38.101-3] for carrier  of serving cell  in PUSCH transmission occasion .

-  is a parameter composed of the sum of a component  and a component  where .

- If a UE established dedicated RRC connection using a Type-1 random access procedure, as described in clause 8, and is not provided *P0-PUSCH-AlphaSet* or for a PUSCH (re)transmission corresponding to a RAR UL grant as described in clause 8.3,

, , and ,

where is provided by *preambleReceivedTargetPower* [11, TS 38.321] and is provided by *msg3-DeltaPreamble*, or  dB if *msg3-DeltaPreamble* is not provided, for carrier  of serving cell 

- If a UE established dedicated RRC connection using a Type-2 random access procedure, as described in clause 8, and is not provided *P0-PUSCH-AlphaSet*,or for a PUSCH transmission for Type-2 random access procedure as described in clause 8.1A,

, , and ,

where is provided by *msgA-preambleReceivedTargetPower*, or by *preambleReceivedTargetPower* if *msgA-preambleReceivedTargetPower* isnot provided and is provided by *msgA-DeltaPreamble*, or dB if *msgA-DeltaPreamble* is not provided, for carrier of serving cell

- For a PUSCH (re)transmission configured by *ConfiguredGrantConfig*, ,  is provided by *p0-NominalWithoutGrant*, or  if *p0-NominalWithoutGrant* is not provided, and  is provided by *p0* obtained from *p0-PUSCH-Alpha* in *ConfiguredGrantConfig* that provides an index *P0-PUSCH-AlphaSetId* to a set of *P0-PUSCH-AlphaSet* for active UL BWP  of carrier  of serving cell 

- For , a  value, applicable for all , is provided by *p0-NominalWithGrant,* or  if *p0-NominalWithGrant* is not provided, for each carrier  of serving cell  and a set of values are provided by a set of *p0* in *P0-PUSCH-AlphaSet* indicated by a respective set of *p0-PUSCH-AlphaSetId* for active UL BWP  of carrier  of serving cell 

- If the UE is provided by *SRI-PUSCH-PowerControl* more than one values of *p0-PUSCH-AlphaSetId* and if a DCI format scheduling the PUSCH transmission includes an SRI field, the UE obtains a mapping from *sri-PUSCH-PowerControlId* in *SRI-PUSCH-PowerControl* between a set of values for the SRI field in the DCI format [5, TS 38.212] and a set of indexes provided by *p0-PUSCH-AlphaSetId* that map to a set of *P0-PUSCH-AlphaSet* values and determines the value of  from the *p0-PUSCH-AlphaSetId* value that is mapped to the SRI field value. If the DCI format also includes an open-loop power control parameter set indication field and a value of the open-loop power control parameter set indication field is '1', the UE determines a value of  from a first value in *P0-PUSCH-Set* with a *p0-PUSCH-SetId* value mapped to the SRI field value.

- If the PUSCH transmission except for the PUSCH retransmission corresponding to a RAR UL grant is scheduled by a DCI format that does not include an SRI field, or if *SRI-PUSCH-PowerControl* is not provided to the UE, ,

- If *P0-PUSCH-Set* is provided to the UE and the DCI format includes an open-loop power control parameter set indication field, the UE determines a value of  from

- a first *P0-PUSCH-AlphaSet* in *p0-AlphaSets* if a value of the open-loop power control parameter set indication field is '0' or '00'

- a first value in *P0-PUSCH-Set* with the lowest *p0-PUSCH-SetID* value if a value of the open-loop power control parameter set indication field is '1' or '01'

- a second value in *P0-PUSCH-Set* with the lowest *p0-PUSCH-SetID* value if a value of the open-loop power control parameter set indication field is '10'

- else, the UE determines  from the value of the first *P0-PUSCH-AlphaSet* in *p0-AlphaSets*

- For 

- For ,

- if and *msgA-Alpha* is provided, is the value of *msgA-Alpha*

- elseif or *msgA-Alpha* is not provided, and *msg3-Alpha* is provided,  is the value of *msg3-Alpha*

- else, 

- For ,  is provided by *alpha* obtained from *p0-PUSCH-Alpha* in *ConfiguredGrantConfig* providing an index *P0-PUSCH-AlphaSetId* to a set of *P0-PUSCH-AlphaSet* for active UL BWP  of carrier  of serving cell 

- For , a set of  values are provided by a set of *alpha* in *P0-PUSCH-AlphaSet* indicated by a respective set of *p0-PUSCH-AlphaSetId* for active UL BWP  of carrier  of serving cell 

- If the UE is provided *SRI-PUSCH-PowerControl* and more than one values of *p0-PUSCH-AlphaSetId*, and if a DCI format scheduling the PUSCH transmission includes an SRI field, the UE obtains a mapping from *sri-PUSCH-PowerControlId* in *SRI-PUSCH-PowerControl* between a set of values for the SRI field in the DCI format [5, TS 38.212] and a set of indexes provided by *p0-PUSCH-AlphaSetId* that map to a set of *P0-PUSCH-AlphaSet* values and determines the values of  from the *p0-PUSCH-AlphaSetId* value that is mapped to the SRI field value

- If the PUSCH transmission except for the PUSCH retransmission corresponding to a RAR UL grant is scheduled by a DCI format that does not include an SRI field, or if *SRI-PUSCH-PowerControl* is not provided to the UE, , and the UE determines  from the value of the first *P0-PUSCH-AlphaSet* in *p0-AlphaSets*

-  is the bandwidth of the PUSCH resource assignment expressed in number of resource blocks for PUSCH transmission occasion on active UL BWP  of carrier  of serving cell and  is a SCS configuration defined in [4, TS 38.211]

- is a downlink pathloss estimate in dB calculated by the UE using reference signal (RS) index for the active DL BWP, as described in clause 12, of carrier of serving cell

- If the UE is not provided *PUSCH-PathlossReferenceRS* and *enableDefaultBeamPL-ForSRS*,or before the UE is provided dedicated higher layer parameters, the UE calculates  using a RS resource from an SS/PBCH block with same SS/PBCH block index as the one the UE uses to obtain *MIB*

- If the UE is configured with a number of RS resource indexes, up to the value of *maxNrofPUSCH-PathlossReferenceRSs*, and a respective set of RS configurations for the number of RS resource indexes by *PUSCH-PathlossReferenceRS*, the set of RS resource indexes can include one or both of a set of SS/PBCH block indexes, each provided by *ssb-Index* when a value of a corresponding *pusch-PathlossReferenceRS-Id* maps to a SS/PBCH block index, and a set of CSI-RS resource indexes, each provided by *csi-RS-Index* when a value of a corresponding *pusch-PathlossReferenceRS-Id* maps to a CSI-RS resource index. The UE identifies a RS resource index in the set of RS resource indexes to correspond either to a SS/PBCH block index or to a CSI-RS resource index as provided by *pusch-PathlossReferenceRS-Id* in *PUSCH-PathlossReferenceRS*

- If the PUSCH transmission is scheduled by a RAR UL grant as described in clause 8.3, or for a PUSCH transmission for Type-2 random access procedure as described in clause 8.1A, the UE uses the same RS resource index as for a corresponding PRACH transmission

- If the UE is provided *SRI-PUSCH-PowerControl* and more than one values of *PUSCH-PathlossReferenceRS-Id*, the UE obtains a mapping from *sri-PUSCH-PowerControlId* in *SRI-PUSCH-PowerControl* between a set of values for the SRI field in a DCI format scheduling the PUSCH transmission and a set of *PUSCH-PathlossReferenceRS-Id* values and determines the RS resource index from the value of *PUSCH-PathlossReferenceRS-Id* that is mapped to the SRI field value where the RS resource is either on serving cell or, if provided, on a serving cell indicated by a value of *pathlossReferenceLinking*

- If the PUSCH transmission is scheduled by DCI format 0\_0, and if the UE is provided a spatial setting by PUCCH-SpatialRelationInfo for a PUCCH resource with a lowest index for active UL BWP of each carrier and serving cell , as described in clause 9.2.2, the UE uses the same RS resource index as for a PUCCH transmission in the PUCCH resource with the lowest index

- If the PUSCH transmission is not scheduled by DCI format 0\_0, and if the UE is provided *enableDefaultBeamPL-ForSRS* and is not provided *PUSCH-PathlossReferenceRS* and *PUSCH-PathlossReferenceRS-r16,* the UE uses the same RS resource index as for an SRS resource set with an SRS resource associated with the PUSCH transmission

- If

- the PUSCH transmission is scheduled by DCI format 0\_0 and the UE is not provided a spatial setting for a PUCCH transmission, or

- the PUSCH transmission is scheduled by DCI format 0\_1 or DCI format 0\_2 that does not include an SRI field, or

- *SRI-PUSCH-PowerControl* is not provided to the UE,

the UE determines a RS resource index with a respective *PUSCH-PathlossReferenceRS-Id* value being equal to zero where the RS resource is either on serving cell or, if provided, on a serving cell indicated by a value of *pathlossReferenceLinking*

- If

- the PUSCH transmission is scheduled by DCI format 0\_0 on serving cell ,

- the UE is not provided PUCCH resources for the active UL BWP of serving cell , and

- the UE is provided *enableDefaultBeamPL-ForPUSCH0-0*

the UE determines a RS resource index providing a periodic RS resource configured with *qcl-Type* set to 'typeD' in the TCI state or the QCL assumption of a CORESET with the lowest index in the active DL BWP of the serving cell

- If

- the PUSCH transmission is scheduled by DCI format 0\_0 on serving cell ,

- the UE is not provided a spatial setting for PUCCH resources on the active UL BWP of the primary cell [11, TS 38.321], and

- the UE is provided *enableDefaultBeamPL-ForPUSCH0-0*

the UE determines a RS resource index providing a periodic RS resource configured with *qcl-Type* set to 'typeD' in the TCI state or the QCL assumption of a CORESET with the lowest index in the active DL BWP of the serving cell

- For a PUSCH transmission configured by *ConfiguredGrantConfig,* if *rrc-ConfiguredUplinkGrant* is included in *ConfiguredGrantConfig*, a RS resource index  is provided by a value of *pathlossReferenceIndex* included in *rrc-ConfiguredUplinkGrant* where the RS resource is either on serving cell or, if provided, on a serving cell indicated by a value of *pathlossReferenceLinking*

- For a PUSCH transmission configured by *ConfiguredGrantConfig* that does not include *rrc-ConfiguredUplinkGrant*, the UE determines a RS resource index  from a value of *PUSCH-PathlossReferenceRS-Id* that is mapped to a SRI field value in a DCI format activating the PUSCH transmission. If the DCI format activating the PUSCH transmission does not include an SRI field, the UE determines a RS resource index  with a respective *PUSCH-PathlossReferenceRS-Id* value being equal to zero where the RS resource is either on serving cell or, if provided, on a serving cell indicated by a value of *pathlossReferenceLinking*

- If the UE is provided *enablePL-RS-UpdateForPUSCH-SRS*, a mapping between *sri-PUSCH-PowerControlId* and *PUSCH-PathlossReferenceRS-Id* values can be updated by a MAC CE as described in [11, TS38.321]

- For a PUSCH transmission scheduled by a DCI format that does not include an SRI field, or for a PUSCH transmission configured by *ConfiguredGrantConfig* and activated, as described in clause 10.2, by a DCI format that does not include an SRI field, a RS resource index  is determined from the *PUSCH-PathlossReferenceRS-Id* mapped to *sri-PUSCH-PowerControlId* = 0

= *referenceSignalPower* – higher layer filtered RSRP, where *referenceSignalPower* is provided by higher layers and RSRP is defined in [7, TS 38.215] for the reference serving cell and the higher layer filter configuration provided by *QuantityConfig* is defined in [12, TS 38.331] for the reference serving cell

If the UE is not configured periodic CSI-RS reception, *referenceSignalPower* is provided by *ss-PBCH-BlockPower*. If the UE is configured periodic CSI-RS reception, *referenceSignalPower* is provided either by *ss-PBCH-BlockPower* or by *powerControlOffsetSS* providing an offset of the CSI-RS transmission power relative to the SS/PBCH block transmission power [6, TS 38.214]. If *powerControlOffsetSS* is not provided to the UE, the UE assumes an offset of 0 dB.

-  for  and  for  where  is provided by *deltaMCS* for each UL BWP  of each carrier  and serving cell . If the PUSCH transmission is over more than one layer [6, TS 38.214], .  and , for active UL BWP  of each carrier  and each serving cell , are computed as below

-  for PUSCH with UL-SCH data and **** for CSI transmission in a PUSCH without UL-SCH data, where

-  is a number of transmitted code blocks,  is a size for code block , and  is a number of resource elements determined as , where is provided by *numberOfSlotsTBoMS* as described in [6, TS 38.214] and if *numberOfSlotsTBoMS* is not provided,  is a number of symbols for PUSCH transmission occasion on active UL BWP  of carrier  of serving cell,  is a number of subcarriers excluding DM-RS subcarriers and phase-tracking RS samples [4, TS 38.211] in PUSCH symbol  and assuming no segmentation for a nominal repetition in case the PUSCH transmission is with repetition Type B, , and ,  are defined in [5, TS 38.212]

-  when the PUSCH includes UL-SCH data and , as described in clause 9.3, when the PUSCH includes CSI and does not include UL-SCH data

-  is the modulation order and  is the target code rate, as described in [6, TS 38.214], provided by the DCI format scheduling the PUSCH transmission that includes CSI and does not include UL-SCH data

- For the PUSCH power control adjustment state  for active UL BWP  of carrier  of serving cell  in PUSCH transmission occasion 

-  is a TPC command value included in a DCI format that schedules the PUSCH transmission occasion  on active UL BWP  of carrier  of serving cell  or jointly coded with other TPC commands in a DCI format 2\_2 with CRC scrambled by TPC-PUSCH-RNTI, as described in clause 11.3

-  if the UE is configured with *twoPUSCH-PC-AdjustmentStates* and  if the UE is not configured with *twoPUSCH-PC-AdjustmentStates* or if the PUSCH transmission is scheduled by a RAR UL grant as described in clause 8.3

- For a PUSCH (re)transmission configured by *ConfiguredGrantConfig*, the value of  is provided to the UE by *powerControlLoopToUse*

- If the UE is provided *SRI-PUSCH-PowerControl*, the UE obtains a mapping between a set of values for the SRI field in a DCI format scheduling the PUSCH transmission and the  value(s) provided by *sri-PUSCH-ClosedLoopIndex* and determines the  value that is mapped to the SRI field value

- If the PUSCH transmission is scheduled by a DCI format that does not include an SRI field, or if an *SRI-PUSCH-PowerControl* is not provided to the UE, 

- If the UE obtains one TPC command from a DCI format 2\_2 with CRC scrambled by a TPC-PUSCH-RNTI, the  value is provided by the closed loop indicator field in DCI format 2\_2

-  is the PUSCH power control adjustment state  for active UL BWP  of carrier  of serving cell  and PUSCH transmission occasion  if the UE is not provided *tpc-Accumulation*, where

- The  values are given in Table 7.1.1-1

-  is a sum of TPC command values in a set  of TPC command values with cardinality  that the UE receives between  symbols before PUSCH transmission occasion  and  symbols before PUSCH transmission occasion  on active UL BWP  of carrier  of serving cell  for PUSCH power control adjustment state , where  is the smallest integer for which  symbols before PUSCH transmission occasion  is earlier than  symbols before PUSCH transmission occasion 

- If the UE is provided *PUSCH-DMRS-Bundling* = ‘enabled’, and for processing TPC command values provided by DCI format 2\_2 with CRC scrambled by TPC-PUSCH-RNTI, a transmission occasion includes repetitions over a time domain window provided by *PUSCH-DMRS-WindowLength*; otherwise, if *PUSCH-DMRS-WindowLength* is not provided, the time domain window is determined as described in[6, TS 38.214]

- If a PUSCH transmission is scheduled by a DCI format,  is a number of symbols for active UL BWP  of carrier  of serving cell  after a last symbol of a corresponding PDCCH reception and before a first symbol of the PUSCH transmission

- If a PUSCH transmission is configured by *ConfiguredGrantConfig*,  is a number of  symbols equal to the product of a number of symbols per slot, , and the minimum of the values provided by *k2* in *PUSCH-ConfigCommon* for active UL BWP  of carrier  of serving cell 

- If the UE has reached maximum power for active UL BWP of carrier  of serving cell  at PUSCH transmission occasion  and , then 

- If UE has reached minimum power for active UL BWP of carrier  of serving cell  at PUSCH transmission occasion  and , then 

- A UE resets accumulation of a PUSCH power control adjustment state  for active UL BWP  of carrier  of serving cell  to 

- If a configuration for a corresponding  value is provided by higher layers

- If a configuration for a corresponding  value is provided by higher layers

where  is determined from the value of  as

- If  and the UE is provided higher *SRI-PUSCH-PowerControl*,  is the *sri-PUSCH-ClosedLoopIndex* value(s) configured in any *SRI-PUSCH-PowerControl* with the *sri-P0-PUSCH-AlphaSetId* value corresponding to 

- If  and the UE is not provided *SRI-PUSCH-PowerControl* or , 

- If ,  is provided by the value of *powerControlLoopToUse*

-  is the PUSCH power control adjustment state for active UL BWP  of carrier  of serving cell  and PUSCH transmission occasion  if the UE is provided *tpc-Accumulation*, where  absolute values are given in Table 7.1.1-1. If the UE is provided *PUSCH-DMRS-Bundling* = ‘enabled’, and for processing TPC command values provided by DCI format 2\_2 with CRC scrambled by TPC-PUSCH-RNTI, a transmission occasion includes repetitions over a time domain window provided by *PUSCH-TimeDomainWindowLength*; otherwise, if *PUSCH-DMRS-WindowLength* is not provided, the time domain window is determined as described in[6, TS 38.214].

- If the UE receives a random access response message in response to a PRACH transmission or a MsgA transmission on active UL BWP  of carrier  of serving cell  as described in clause 8

- , where  and

-  is a TPC command value indicated in a random access response grant of the random access response message corresponding to a PRACH transmission according to Type-1 random access procedure, or in a random access response grant of the random access response message corresponding to a MsgA transmission according to Type-2 random access procedure with RAR message(s) for fallbackRAR, on active UL BWP  of carrier  in the serving cell , and

-  and  is provided by higher layers and corresponds to the total power ramp-up requested by higher layers from the first to the last random access preamble for carrier  in the serving cell ,  is the bandwidth of the PUSCH resource assignment expressed in number of resource blocks for the first PUSCH transmission on active UL BWP  of carrier  of serving cell, and  is the power adjustment of first PUSCH transmission on active UL BWP  of carrier  of serving cell .

- If the UE transmits the PUSCH in PUSCH transmission occasion on active UL BWP of carrier of serving cell as described in clause 8.1A, , where

- , and

-  and is provided by higher layers and corresponds to the total power ramp-up requested by higher layers, is the bandwidth of the PUSCH resource assignment expressed in number of resource blocks, and is the power adjustment of the PUSCH transmission in PUSCH transmission occasion .

Table 7.1.1-1: Mapping of TPC Command Field in a DCI format scheduling a PUSCH transmission, or in DCI format 2\_2 with CRC scrambled by TPC-PUSCH-RNTI, or in DCI format 2\_3, to absolute and accumulated  values or  values

|  |  |  |
| --- | --- | --- |
| TPC Command Field | Accumulated  or  [dB] | Absolute  or  [dB] |
| 0 | -1 | -4 |
| 1 | 0 | -1 |
| 2 | 1 | 1 |
| 3 | 3 | 4 |

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

### 7.2.1 UE behaviour

If a UE transmits a PUCCH on active UL BWP  of carrier  in the primary cell  using PUCCH power control adjustment state with index , the UE determines the PUCCH transmission power  in PUCCH transmission occasion  as

 [dBm]

where

-  is the UE configured maximum output power defined in [8-1, TS 38.101-1], [8-2, TS38.101-2] and [8-3, TS38.101-3] for carrier  of primary cell  in PUCCH transmission occasion 

-  is a parameter composed of the sum of a component , provided by *p0-nominal*, or  dBm if *p0-nominal* is not provided, for carrier  of primary cell  and, if provided, a component  provided by *p0-PUCCH-Value* in *P0-PUCCH* for active UL BWP  of carrier  of primary cell , where .  is a size for a set of  values provided by *maxNrofPUCCH-P0-PerSet*. The set of  values is provided by *p0-Set*. If *p0-Set* is not provided to the UE, , 

- If the UE is provided *PUCCH-SpatialRelationInfo*, the UE obtains a mapping, by an index provided by *p0-PUCCH-Id*, between a set of *pucch-SpatialRelationInfoId* values and a set of *p0-PUCCH-Value* values. If the UE is provided more than one values for *pucch-SpatialRelationInfoId* and the UE receives an activation command [11, TS 38.321] indicating a value of *pucch-SpatialRelationInfoId*, the UE determines the *p0-PUCCH-Value* value through the link to a corresponding *p0-PUCCH-Id* index. The UE applies the activation command in the first slot that is after slot  where  is the slot where the UE would transmit a PUCCH with HARQ-ACK information for the PDSCH providing the activation command and  is the SCS configuration for the PUCCH

- If the UE is not provided *PUCCH-SpatialRelationInfo*, the UE obtains the *p0-PUCCH-Value* value from the *P0-PUCCH* with *p0-PUCCH-Id* value equal to the minimum *p0-PUCCH-Id* value in *p0-Set*

-  is a bandwidth of the PUCCH resource assignment expressed in number of resource blocks for PUCCH transmission occasion on active UL BWP  of carrier  of primary cell and  is a SCS configuration defined in [4, TS 38.211]

- is a downlink pathloss estimate in dB calculated by the UE using RS resource index  as described in clause 7.1.1 for the active DL BWP  of carrier  of the primary cell  as described in clause 12

- If the UE is not provided *pathlossReferenceRSs* or before the UE is provided dedicated higher layer parameters, the UE calculates  using a RS resource obtained from an SS/PBCH block with same SS/PBCH block index as the one the UE uses to obtain *MIB*

- If the UE is provided a number of RS resource indexes, the UE calculates  using RS resource with index , where .  is a size for a set of RS resources provided by *maxNrofPUCCH-PathlossReferenceRSs*. The set of RS resources is provided by *pathlossReferenceRSs*. The set of RS resources can include one or both of a set of SS/PBCH block indexes, each provided by *ssb-Index* in *PUCCH-PathlossReferenceRS* when a value of a corresponding *pucch-PathlossReferenceRS-Id* maps to a SS/PBCH block index, and a set of CSI-RS resource indexes, each provided by *csi-RS-Index* when a value of a corresponding *pucch-PathlossReferenceRS-Id* maps to a CSI-RS resource index. The UE identifies a RS resource in the set of RS resources to correspond either to a SS/PBCH block index or to a CSI-RS resource index as provided by *pucch-PathlossReferenceRS-Id* in *PUCCH-PathlossReferenceRS*

- If the UE is provided *pathlossReferenceRSs* and *PUCCH-SpatialRelationInfo*, the UE obtains a mapping, by indexes provided by corresponding values of *pucch-PathlossReferenceRS-Id*, between a set of *pucch-SpatialRelationInfoId* values and a set of *referenceSignal* values provided by *PUCCH-PathlossReferenceRS*. If the UE is provided more than one values for *pucch-SpatialRelationInfoId* and the UE receives an activation command [11, TS 38.321] indicating a value of *pucch-SpatialRelationInfoId*, the UE determines the *referenceSignal* value in *PUCCH-PathlossReferenceRS* through the link to a corresponding *pucch-PathlossReferenceRS-Id* index. The UE applies the activation command in the first slot that is after slot  where  is the slot where the UE would transmit a PUCCH with HARQ-ACK information for the PDSCH providing the activation command and  is the SCS configuration for the PUCCH

- If *PUCCH-SpatialRelationInfo* includes *servingCellId* indicating a serving cell, the UE receives the RS for resource index  on the active DL BWP of the serving cell

- If the UE is provided *pathlossReferenceRSs* and is not provided *PUCCH-SpatialRelationInfo*, the UE obtains the *referenceSignal* value in *PUCCH-PathlossReferenceRS* from the *pucch-PathlossReferenceRS-Id* with index 0 in *PUCCH-PathlossReferenceRS* where the RS resource is either on the primary cell or, if provided, on a serving cell indicated by a value of *pathlossReferenceLinking*

- If the UE

- is not provided *pathlossReferenceRSs*, and

- is not provided *PUCCH-SpatialRelationInfo,* and

- is provided *enableDefaultBeamPL-ForPUCCH*, and

- is not provided coresetPoolIndex value of 1 for any CORESET, or is provided coresetPoolIndex value of 1 for all CORESETs, in ControlResourceSet and no codepoint of a TCI field, if any, in a DCI format of any search space set maps to two TCI states [5, TS 38.212]

the UE determines a RS resource index providing a periodic RS resource configured with *qcl-Type* set to 'typeD' in the TCI state or the QCL assumption of a CORESET with the lowest index in the active DL BWP of the primary cell. For a PUCCH transmission over multiple slots, a same applies to the PUCCH transmission in each of the multiple slots.

- The parameter  is a value of *deltaF-PUCCH-f0* for PUCCH format 0, *deltaF-PUCCH-f1* for PUCCH format 1, *deltaF-PUCCH-f2* for PUCCH format 2, *deltaF-PUCCH-f3* for PUCCH format 3, and *deltaF-PUCCH-f4* for PUCCH format 4, if provided; otherwise .

-  is a PUCCH transmission power adjustment component on active UL BWP  of carrier  of primary cell 

- For a PUCCH transmission using PUCCH format 0 or PUCCH format 1,  where

-  is a number of PUCCH format 0 symbols or PUCCH format 1 symbols for the PUCCH transmission as described in clause 9.2.

-  for PUCCH format 0

-  for PUCCH format 1

-  for PUCCH format 0

-  for PUCCH format 1, where  is a number of UCI bits in PUCCH transmission occasion 

- For a PUCCH transmission using PUCCH format 2 or PUCCH format 3 or PUCCH format 4 and for a number of UCI bits smaller than or equal to 11, , where

- 

-  is a number of HARQ-ACK information bits that the UE determines as described in clause 9.1.2.1 or 16.5.1.1 for Type-1 HARQ-ACK codebook and as described in clause 9.1.3.1 or 9.1.3.3 or 16.5.2.1 for Type-2 HARQ-ACK codebook.is the same as  as described in clause 9.1.4 for Type-3 HARQ-ACK codebook. If the UE is not provided any of *pdsch-HARQ-ACK-Codebook*, *pdsch-HARQ-ACK-Codebook-r16*, or *pdsch-HARQ-ACK-OneShotFeedback*,  if the UE includes a HARQ-ACK information bit in the PUCCH transmission; otherwise, 

-  is a number of SR information bits that the UE determines as described in clause 9.2.5.1

-  is a number of CSI information bits that the UE determines as described in clause 9.2.5.2

-  is a number of resource elements determined as , where  is a number of subcarriers per resource block excluding subcarriers used for DM-RS transmission, and  is a number of symbols excluding symbols used for DM-RS transmission, as defined in clause 9.2.5.2, for PUCCH transmission occasion on active UL BWP  of carrier  of primary cell

- For a PUCCH transmission using PUCCH format 2 or PUCCH format 3 or PUCCH format 4 and for a number of UCI bits larger than 11, , where

- 

- 

-  is a number of HARQ-ACK information bits that the UE determines as described in clause 9.1.2.1 or 16.5.1.1 for Type-1 HARQ-ACK codebook and as described in clause 9.1.3.1 or 9.1.3.3 or 16.5.2.1 for Type-2 HARQ-ACK codebook, or as described in clause 9.1.4 for Type-3 HARQ-ACK codebook. If the UE is not provided any of *pdsch-HARQ-ACK-Codebook*, *pdsch-HARQ-ACK-Codebook-r16*, or *pdsch-HARQ-ACK-OneShotFeedback*,  if the UE includes a HARQ-ACK information bit in the PUCCH transmission; otherwise, 

-  is a number of SR information bits that the UE determines as described in clause 9.2.5.1

-  is a number of CSI information bits that the UE determines as described in clause 9.2.5.2

-  is a number of CRC bits that the UE determines as described in clause 9.2

-  is a number of resource elements that the UE determines as , where  is a number of subcarriers per resource block excluding subcarriers used for DM-RS transmission, and  is a number of symbols excluding symbols used for DM-RS transmission, as defined in clause 9.2.5.2, for PUCCH transmission occasion on active UL BWP  of carrier  of primary cell.

- For the PUCCH power control adjustment state  for active UL BWP  of carrier  of primary cell  and PUCCH transmission occasion 

-  is a TPC command value included in a DCI format scheduling a PDSCH reception for active UL BWP  of carrier  of the primary cell  that the UE detects for PUCCH transmission occasion , or is jointly coded with other TPC commands in a DCI format 2\_2 with CRC scrambled by TPC-PUCCH-RNTI [5, TS 38.212], as described in clause 11.3

-  if the UE is provided *twoPUCCH-PC-AdjustmentStates* and *PUCCH-SpatialRelationInfo* and  if the UE is not provided *twoPUCCH-PC-AdjustmentStates* or *PUCCH-SpatialRelationInfo*

- If the UE obtains a TPC command value from a DCI format scheduling a PDSCH reception and if the UE is provided *PUCCH-SpatialRelationInfo*, the UE obtains a mapping, by an index provided by *p0-PUCCH-Id*, between a set of *pucch-SpatialRelationInfoId* values and a set of values for *closedLoopIndex* that provide the  value(s). If the UE receives an activation command indicating a value of *pucch-SpatialRelationInfoId*, the UE determines the value *closedLoopIndex* that provides the value of  through the link to a corresponding *p0-PUCCH-Id* index

- If the UE obtains one TPC command from a DCI format 2\_2 with CRC scrambled by a TPC-PUCCH-RNTI, the  value is provided by the closed loop indicator field in DCI format 2\_2

-  is the current PUCCH power control adjustment state  for active UL BWP  of carrier  of primary cell  and PUCCH transmission occasion , where

- The  values are given in Table 7.1.2-1

-  is a sum of TPC command values in a set  of TPC command values with cardinality  that the UE receives between  symbols before PUCCH transmission occasion  and  symbols before PUCCH transmission occasion  on active UL BWP  of carrier  of primary cell  for PUCCH power control adjustment state, where  is the smallest integer for which  symbols before PUCCH transmission occasion  is earlier than  symbols before PUCCH transmission occasion 

- If the UE is provided *PUCCH-DMRS-Bundling* = ‘enabled’, and for processing TPC command values provided by DCI format 2\_2 with CRC scrambled by TPC-PUCCH-RNTI, a transmission occasion includes repetitions over a time domain window provided by *PUCCH-DMRS-WindowLength*; otherwise, if *PUCCH-DMRS-WindowLength* is not provided, the time domain windowis determined as described in[6, TS 38.214]

- If the PUCCH transmission is in response to a detection by the UE of a DCI format,  is a number of symbols for active UL BWP  of carrier  of primary cell  after a last symbol of a corresponding PDCCH reception and before a first symbol of the PUCCH transmission

- If the PUCCH transmission is not in response to a detection by the UE of a DCI format,  is a number of  symbols equal to the product of a number of symbols per slot, , and the minimum of the values provided by *k2* in *PUSCH-ConfigCommon* for active UL BWP  of carrier  of primary cell 

- If the UE has reached maximum power for active UL BWP  of carrier  of primary cell  at PUCCH transmission occasion  and , then 

- If UE has reached minimum power for active UL BWP  of carrier  of primary cell  at PUCCH transmission occasion  and , then 

- If a configuration of a  value for a corresponding PUCCH power control adjustment state  for active UL BWP  of carrier  of primary cell  is provided by higher layers,

- 

If the UE is provided *PUCCH-SpatialRelationInfo*, the UE determines the value of  from the value of  based on a *pucch-SpatialRelationInfoId* value associated with the *p0-PUCCH-Id* value corresponding to  and with the *closedLoopIndex* value corresponding to ; otherwise, 

- Else,

- , where , and  is

- the TPC command value indicated in a random access response grant corresponding to a PRACH transmission according to Type-1 random access procedure, or in a random access response grant corresponding to MsgA transmissions according to Type-2 random access procedure with RAR message(s) for fallbackRAR, or

- the TPC command value indicated in a successRAR corresponding to MsgA transmissions for Type-2 random access procedure, or

- the TPC command value in a DCI format with CRC scrambled by C-RNTI or MCS-C-RNTI that the UE detects in a first PDCCH reception in a search space set provided by *recoverySearchSpaceId* if the PUCCH transmission is a first PUCCH transmission after 28 symbols from a last symbol of the first PDCCH reception,

and, if the UE transmits PUCCH on active UL BWP  of carrier  of primary cell ,

;

otherwise,

 where  is provided by higher layers and corresponds to the total power ramp-up requested by higher layers from the first to the last preamble for active UL BWP  of carrier  of primary cell , and  corresponds to PUCCH format 0 or PUCCH format 1

Table 7.2.1-1: Mapping of TPC Command Field in a DCI format to accumulated  values

|  |  |
| --- | --- |
| TPC Command Field | Accumulated  [dB] |
| 0 | -1 |
| 1 | 0 |
| 2 | 1 |
| 3 | 3 |

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

## 8.3 PUSCH scheduled by RAR UL grant

An active UL BWP, as described in clause 12 and in [4, TS 38.211], for a PUSCH transmission scheduled by a RAR UL grant is indicated by higher layers.

If *useInterlacePUCCH-PUSCH* is not provided by *BWP-UplinkCommon* and *BWP-UplinkDedicated*, for determining the frequency domain resource allocation for the PUSCH transmission within the active UL BWP

- if the active UL BWP and the initial UL BWP have same SCS and same CP length and the active UL BWP includes all RBs of the initial UL BWP, or the active UL BWP is the initial UL BWP, the initial UL BWP is used

- else, the RB numbering starts from the first RB of the active UL BWP and the maximum number of RBs for frequency domain resource allocation equals the number of RBs in the initial UL BWP

The frequency domain resource allocation is by uplink resource allocation type 1 [6, TS 38.214]. For an initial UL BWP size of RBs, a UE processes the frequency domain resource assignment field as follows

- if , or for operation with shared spectrum channel access if

- truncate the frequency domain resource assignment field to its least significant bits and interpret the truncated frequency resource assignment field as for the frequency resource assignment field in DCI format 0\_0 as described in [5, TS 38.212]

- else

- insert most significant bits, or for operation with shared spectrum channel access insert most significant bits, with value set to '0' after the bits to the frequency domain resource assignment field, where if the frequency hopping flag is set to '0' and is provided in Table 8.3-1 if the hopping flag bit is set to '1', and interpret the expanded frequency resource assignment field as for the frequency resource assignment field in DCI format 0\_0 as described in [5, TS 38.212]

- end if

If *useInterlacePUCCH-PUSCH* is provided by *BWP-UplinkCommon* or *BWP-UplinkDedicated*, the frequency domain resource allocation is by uplink resource allocation type 2 [6, TS 38.214]. A UE processes the frequency domain resource assignment field as follows

- truncate the frequency domain resource assignment field to the LSBs if , or to the LSBs if

- for interlace allocation of a PUSCH transmission, interpret the MSBs of the truncated frequency domain resource assignment field for the active UL BWP as for the MSBs of the frequency domain resource assignment field in DCI format 0\_0 [6, TS 38.214]

- for RB set allocation of a PUSCH transmission, the RB set of the active UL BWP is the RB set of the PRACH transmission associated with the RAR UL grant. The UE assumes that the RB set is defined as when the UE is not provided *intraCellGuardBandsUL-List* [6, TS 38.214].

A UE determines whether or not to apply transform precoding as described in [6, TS 38.214].

For a PUSCH transmission with frequency hopping scheduled by RAR UL grant or for a Msg3 PUSCH retransmission, the frequency offset for the second hop [6, TS 38.214] is given in Table 8.3-1.

Table 8.3-1: Frequency offset for second hop of PUSCH transmission with frequency hopping scheduled by RAR UL grant or of Msg3 PUSCH retransmission

|  |  |  |
| --- | --- | --- |
| Number of PRBs in initial UL BWP | Value of Hopping Bits | Frequency offset for 2nd hop |
|  | 0 |  |
| 1 |  |
|  | 00 |  |
| 01 |  |
| 10 |  |
| 11 | Reserved |

A SCS for the PUSCH transmission is provided by *subcarrierSpacing* in *BWP-UplinkCommon*. A UE transmits PRACH and the PUSCH on a same uplink carrier of a same serving cell.

A UE transmits a transport block in a PUSCH scheduled by a RAR UL grant in a corresponding RAR message using redundancy version number 0, if the PUSCH transmission is without repetitions. If a TC-RNTI is provided by higher layers, the scrambling initialization of the PUSCH corresponding to the RAR UL grant in clause 8.2 is by TC-RNTI. Otherwise, the scrambling initialization of the PUSCH corresponding to the RAR UL grant in clause 8.2 is by C-RNTI.

Msg3 PUSCH retransmissions, if any, of the transport block, are scheduled by a DCI format 0\_0 with CRC scrambled by a TC-RNTI provided in the corresponding RAR message [11, TS 38.321].

With reference to slots for a PUSCH transmission scheduled by a RAR UL grant, if a UE receives a PDSCH with a RAR message ending in slot for a corresponding PRACH transmission from the UE, the UE transmits the PUSCH in slot , where and are provided in [6, TS 38.214].

A UE can be provided in *RACH-ConfigCommon* a set of numbers of repetitions for a PUSCH transmission with PUSCH repetition Type A that is scheduled by a RAR UL grant or by a DCI format 0\_0 with CRC scrambled by a TC-RNTI. The UE repeats the PUSCH transmission over slots, where is indicated by the 2 MSBs of the MCS field in the RAR UL grant or in the DCI format 0\_0 with CRC scrambled by the TC-RNTI, and determines a redundancy version and RBs for each repetition as described in [6, TS 38.214]. For unpaired spectrum operation, the UE determines the slots as the first slots starting from slot where a repetition of the PUSCH transmission does not include a symbol indicated as downlink by *tdd-UL-DL-ConfigurationCommon* or indicated as a symbol of an SS/PBCH block with index provided by *ssb-PositionsInBurst*.

The UE may assume a minimum time between the last symbol of a PDSCH reception conveying a RAR message with a RAR UL grant and the first symbol of a corresponding PUSCH transmission scheduled by the RAR UL grant is equal to msec, where is a time duration of symbols corresponding to a PDSCH processing time for UE processing capability 1 when additional PDSCH DM-RS is configured, is a time duration of symbols corresponding to a PUSCH preparation time for UE processing capability 1 [6, TS 38.214] and, for determining the minimum time, the UE considers that and correspond to the smaller of the SCS configurations for the PDSCH and the PUSCH. For , the UE assumes [6, TS 38.214].

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

### 9.2.6 PUCCH repetition procedure

A UE can be indicated to transmit a PUCCH over slots using a PUCCH resource, where

- if the PUCCH resource is indicated by a DCI format and includes *PUCCH-nrofSlots*, is provided by *PUCCH-nrofSlots*

- otherwise, is provided by *nrofSlots*

If a UE is provided a *PUCCH-config* that includes *subslotLengthForPUCCH,* the UE does not expect the *PUCCH-config* to include *nrofSlots*.

For ,

- the UE repeats the PUCCH transmission with the UCI over slots

- a PUCCH transmission in each of the slots has a same number of consecutive symbols, as provided by *nrofSymbols*

- a PUCCH transmission in each of the slots has a same first symbol, as provided by *startingSymbolIndex*

- the UE is configured by *interslotFrequencyHopping* whether or not to perform frequency hopping for PUCCH transmissions in different slots

- if the UE is configured to perform frequency hopping for PUCCH transmissions across different slots

- the UE performs frequency hopping per slot

- the UE transmits the PUCCH starting from a first PRB, provided by *startingPRB*, in slots with even number and starting from the second PRB, provided by *secondHopPRB*, in slots with odd number. The slot indicated to the UE for the first PUCCH transmission has number 0 and each subsequent slot until the UE transmits the PUCCH in slots is counted regardless of whether or not the UE transmits the PUCCH in the slot

- the UE does not expect to be configured to perform frequency hopping for a PUCCH transmission within a slot

- If the UE is not configured to perform frequency hopping for PUCCH transmissions across different slots and if the UE is configured to perform frequency hopping for a PUCCH transmission within a slot, the frequency hopping pattern between the first PRB and the second PRB is same within each slot

If the UE determines that, for a PUCCH transmission in a slot, the number of symbols available for the PUCCH transmission is smaller than the value provided by *nrofSymbols* for the corresponding PUCCH format, the UE does not transmit the PUCCH in the slot.

A SS/PBCH block symbol is a symbol of an SS/PBCH block with candidate SS/PBCH block index corresponding to the SS/PBCH block index indicated to a UE by *ssb-PositionsInBurst* in *SIB1* or *ssb-PositionsInBurst* in *ServingCellConfigCommon*, as described in clause 4.1.

For unpaired spectrum, the UE determines the slots for a PUCCH transmission starting from a slot indicated to the UE as described in clause 9.2.3 for HARQ-ACK reporting, or a slot determined as described in clause 9.2.4 for SR reporting or in clause 5.2.1.4 of [6, TS 38.214] for CSI reporting and having

- an UL symbol, as described in clause 11.1, or flexible symbol that is not SS/PBCH block symbol provided by *startingSymbolIndex* as a first symbol, and

- consecutive UL symbols, as described in clause 11.1, or flexible symbols that are not SS/PBCH block symbols, starting from the first symbol, equal to or larger than a number of symbols provided by *nrofsymbols*

For paired spectrum or supplementary uplink band, the UE determines the slots for a PUCCH transmission as the consecutive slots starting from a slot indicated to the UE as described in clause 9.2.3 for HARQ-ACK reporting, or a slot determined as described in clause 9.2.4 for SR reporting or in clause 5.2.1.4 of [6, TS 38.214] for CSI reporting.

If a UE would transmit a PUCCH over a first number of slots and the UE would transmit a PUSCH with repetition Type A over a second number of slots, and the PUCCH transmission would overlap with the PUSCH transmission in one or more slots, and the conditions in clause 9.2.5 for multiplexing the UCI in the PUSCH are satisfied in the overlapping slots, the UE transmits the PUCCH and does not transmit the PUSCH in the overlapping slots.

If a UE would transmit a PUCCH over a first number of slots and the UE would transmit a PUSCH with repetition Type B over a second number of slots, and the PUCCH transmission would overlap with actual PUSCH repetitions in one or more slots, and the conditions in clause 9.2.5 for multiplexing the UCI in the PUSCH are satisfied for the overlapping actual PUSCH repetitions, the UE transmits the PUCCH and does not transmit the overlapping actual PUSCH repetitions.

A UE does not multiplex different UCI types in a PUCCH transmission with repetitions over slots. If a UE would transmit a first PUCCH over more than one slot and at least a second PUCCH over one or more slots, and the transmissions of the first PUCCH and the second PUCCH would overlap in a number of slots then, for each slot of the number of slots and with UCI type priority of HARQ-ACK > SR > CSI with higher priority > CSI with lower priority

- the UE does not expect the first PUCCH and any of the second PUCCHs to start at a same slot and include a UCI type with same priority

- if the first PUCCH and any of the second PUCCHs include a UCI type with same priority, the UE transmits the PUCCH starting at an earlier slot and does not transmit the PUCCH starting at a later slot

- if the first PUCCH and any of the second PUCCHs do not include a UCI type with same priority, the UE transmits the PUCCH that includes the UCI type with higher priority and does not transmit the PUCCH that include the UCI type with lower priority

A UE does not expect a PUCCH that is in response to a DCI format detection to overlap with any other PUCCH that does not satisfy the corresponding timing conditions in clause 9.2.5.

If a UE would transmit a PUCCH over slots and the UE does not transmit the PUCCH in a slot from the slots due to overlapping with another PUCCH transmission in the slot, the UE counts the slot in the number of slots.

For DAPS operation, if a UE would transmit a PUCCH over slots on the source MCG and the UE does not transmit the PUCCH in a slot from the slots due to overlapping in time with UE transmission on the target MCG in the slot, the UE counts the slot in the number of slots.