Consolidated Changes

The RIT proposed by TSDSI is building on the 3GPP 5G NR standard and providing enhancements through appropriate modifications of the 3GPP 38 series. In this document, we provide the summary of the changes and the exact changes in the 38 Series. The following changes are proposed.

1. Bandwidth part selection
2. Values of scheduled bandwidth for mapping UL PTRS with transform precoding
3. Fast SRS precoding
4. Non-precoded DMRS for PI/2 BPSK and other enhancements

# Band width part selection

Documents effected

1. 38.331
2. 38.214

The following changes are proposed:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Text Changes to 38 Series**……………………………………………………………………………………………………………………………………….Modification to 38.331-f10……………………………………………………………………………………………………………………………………….**Modify the BWP-IE in section 6.3.2 as follows**(Changes are highlighted and italicized)***LocationAndBandwidthAsRBG ::= SEQUENCE {*** ***-- row index corresponding to RBG Sizes from the set {2,4,8,16}*** ***rbgIndex INTEGER (0..3),***  ***-- number of complete RBGs in the BWP*** ***s1 INTEGER (0..18),*** ***-- Frequency domain location and residual RBs of this bandwidth part defined commonly in a table (FFS\_Section). The location is given as***  ***-- distance (in number of RBGs) to point A (absoluteFrequencyPointA in FrequencyInfoDL).***  ***-- Corresponds to L1 parameter 'DL-BWP-loc'. (see 38.211, section FFS\_Section).***  ***-- In case of TDD, a BWP-pair (UL BWP and DL BWP with the same bwp-Id) must have the same location (see 38.211, section REF)*** ***s2AndLocation INTEGER (0..511)******}***-- Generic parameters used in Uplink- and Downlink bandwidth partsBWP ::= SEQUENCE { ***locationAndBandwidthConfig CHOICE {*** ***locationAndBandwidthAsRBG LocationAndBandwidthAsRBG*** -- Frequency domain location and bandwidth of this bandwidth part defined commonly in a table (FFS\_Section). The location is given as  -- distance (in number of PRBs) to point A (absoluteFrequencyPointA in FrequencyInfoDL).  -- Corresponds to L1 parameter 'DL-BWP-loc'. (see 38.211, section FFS\_Section).  -- In case of TDD, a BWP-pair (UL BWP and DL BWP with the same bwp-Id) must have the same location (see 38.211, section REF) locationAndBandwidth INTEGER (0..37949),  ***}*** -- Subcarrier spacing to be used in this BWP for all channels and  -- reference signals unless explicitly configured elsewhere. -- Corresponds to subcarrier spacing according to 38.211, Table 4.2-1.  -- The value kHz15 corresponds to µ=0, kHz30 to µ=1, and so on. Only the values 15 or 30 kHz (<6GHz), 60 or 120 kHz (>6GHz) are  -- applicable. subcarrierSpacing SubcarrierSpacing, -- Indicates whether to use the extended cyclic prefix for this bandwidth part. If not set, the UE uses the normal cyclic prefix.  -- Normal CP is supported for all numerologies and slot formats. Extended CP is supported only for 60 kHz subcarrier spacing.  -- (see 38.211, section 4.2.2) cyclicPrefix ENUMERATED { extended } OPTIONAL -- Need R}……………………………………………………………………………………………………………………………………….Modification to 38.214-f10……………………………………………………………………………………………………………………………………….**Modify section 5.1.2.2.1 as follows**(Changes are highlighted in red color)In downlink resource allocation of type 0, the resource block assignment information includes a bitmap indicating the Resource Block Groups (RBGs) that are allocated to the scheduled UE where a RBG is a set of consecutive virtual resource blocks. If higher layer parameter *locationAndBandwidth* is selected, RBG is defined by higher layer parameter *rbg-Size* configured for PDSCH and the size of the carrier bandwidth part as defined in Table 5.1.2.2.1-1.Table 5.1.2.2.1-1: Nominal RBG size *P*

|  |  |  |
| --- | --- | --- |
| Bandwidth Part Size | Configuration 1 | Configuration 2 |
| 1 – 36 | 2 | 4 |
| 37 – 72 | 4 | 8 |
| 73 – 144 | 8 | 16 |
| 145 – 275 | 16 | 16 |

If higher layer parameter *locationAndBandwidthAsRBG* is selected, RBG is defined by higher layer parameter *rbg-Size* configured for PDSCH and the *rbgIndex* configured for the carrier bandwidth part as defined in Table 5.1.2.2.1-2.Table 5.1.2.2.1-2: Nominal RBG size *P*

|  |  |  |
| --- | --- | --- |
| *rbgIndex* | Configuration 1 | Configuration 2 |
| 0 | 2 | 4 |
| 1 | 4 | 8 |
| 2 | 8 | 16 |
| 3 | 16 | 16 |

**Modify section 6.1.2.2.1 as follows**In uplink resource allocation of type 0, the resource block assignment information includes a bitmap indicating the Resource Block Groups (RBGs) that are allocated to the scheduled UE where a RBG is a set of consecutive virtual resource blocks. If higher layer parameter *locationAndBandwidth* is selected, RBG is defined by higher layer parameter *rbg-Size* configured for PUSCH and the size of the carrier bandwidth part as defined in Table 6.1.2.2.1-1.Table 6.1.2.2.1-1: Nominal RBG size *P*

|  |  |  |
| --- | --- | --- |
| Carrier Bandwidth Part Size | Configuration 1 | Configuration 2 |
| 1 – 36  | *2* | 4 |
| 37 – 72 | 4 | 8 |
| 73 – 144 | 8 | 16 |
| 145 – 275 | 16 | 16 |

If higher layer parameter *locationAndBandwidthAsRBG* is selected, RBG is defined by higher layer parameters *rbg-Size* configured for PUSCH and the *rbgIndex* configured for the carrier bandwidth part as defined in Table 6.1.2.2.1-2.Table 6.1.2.2.1-2: Nominal RBG size *P*

|  |  |  |
| --- | --- | --- |
| *rbgIndex* | Configuration 1 | Configuration 2 |
| 0 | 2 | 4 |
| 1 | 4 | 8 |
| 2 | 8 | 16 |
| 3 | 16 | 16 |

 |

# Values of scheduled bandwidth for mapping UL PTRS with transform precoding

Documents effected

1. 38.211
2. 38.214

**Proposed Changes**

**38.211**

The UE shall transmit phase-tracking reference signals only in the resource blocks used for the PUSCH, and only if the procedure in [6, TS 38.214] indicates that phase-tracking reference signals are being used.

The sequenceshall be multiplied by and mapped to complex valued symbols in where

- are the complex-valued symbols in OFDM symbol  before transform precoding according to Subclause 6.3.1.4

- depends on the number of PT-RS groups, the number of samples per PT-RS group, and  according toTable 6.4.1.2.2.2-1.

The values of  and  are determined based on Table 6.4.1.2.2.2-2.

## Table 6.4.1.2.2.2-2: Threshold values of scheduled BW (NRBi, i=0,1,2,3,4,5)

|  |  |
| --- | --- |
| **Config0** | **Config1** |
| NRB0 = 0 | NRB0 = 0 |
| NRB1 = 8 | NRB1 = NRB2 = 24 |
| NRB2 = NRB3 = 24 | NRB3 = NRB4 = 96 |
| NRB4 = 96 |  |

Threshold values in Config0 is selected when transmit MCS <10, while threshold values in Config1 is selected when transmit MCS ≥ 10.

**38.214**

When transform precoding is enabled and if a UE is configured with the higher layer parameter *UL-PTRS-present-transform-precoding,*

 - ~~theUE shall be configured with the higher layer parameters~~ *~~sampleDensity~~*~~and the UE shall assume~~ if the UE is configured with higher layer parameters *sampleDensity,* the UE shall assume the PT-RS antenna ports' presence and PT-RS group pattern are a function of the corresponding scheduled bandwidth in a corresponding bandwidth part, as shown in Table 6.2.3.2-1.

 - if the UE is not configured with the higher layer parameters sampleDensity, the threshold values of scheduled bandwidth, i.e., (NRBi, i=0,1,..4) are based on Table 6.4.1.2.2.2-2 in [1, TS 38.211] and the UE shall assume the PT-RS antenna ports' presence and PT-RS group pattern are a function of the corresponding scheduled bandwidth in a corresponding bandwidth part, as shown in Table 6.2.3.2-1.

 - if the higher layer parameter MCS\_Enable is set, then UE shall assume NRB2 = NRB1 and NRB4 = NRB3.

 The UE shall assume no PT-RS is present when the number of scheduled RBs is less than or equal to NRB0 if NRB0> 0 or if the RNTI equals TC-RNTI.

III Changes suggested in *PTRS-UplinkConfig* information element in Section 6.3.2 in TS 38.331 (shown in RED)

*PTRS-UplinkConfig* information element

-- ASN1START

-- TAG-PTRS-UPLINKCONFIG-START

PTRS-UplinkConfig ::= SEQUENCE {

 modeSpecificParameters CHOICE {

 -- Configuration of UL PTRS for CP-OFDM

 cp-OFDM SEQUENCE {

 -- Presence and frequency density of UL PT-RS for CP-OFDM waveform as a function of scheduled BW

 -- If the field is absent, the UE uses K\_PT-RS = 2.

 -- Corresponds to L1 parameter 'UL-PTRS-frequency-density-table' (see 38.214, section 6.1)

 frequencyDensity SEQUENCE (SIZE (2)) OF INTEGER (1..276) OPTIONAL, -- Need S

 -- Presence and time density of UL PT-RS for CP-OFDM waveform as a function of MCS

 -- If the field is absent, the UE uses L\_PT-RS = 1.

 -- Corresponds to L1 parameter 'UL-PTRS-time-density-table' (see 38.214, section 6.1)

 timeDensity SEQUENCE (SIZE (3)) OF INTEGER (0..29) OPTIONAL, -- Need S

 -- The maximum number of UL PTRS ports for CP-OFDM.

 -- Corresponds to L1 parameter 'UL-PTRS-ports' (see 38.214, section 6.2.3.1)

 maxNrofPorts ENUMERATED {n1, n2},

 -- Indicates the subcarrier offset for UL PTRS for CP-OFDM.

 -- Corresponds to L1 parameter 'UL-PTRS-RE-offset' (see 38.214, section 6.1)

 resourceElementOffset ENUMERATED {offset01, offset10, offset11 } OPTIONAL, -- Need S

 -- UL PTRS power boosting factor per PTRS port. Corresponds to L1 parameter 'UL-PTRS-power' (see 38.214, section 6.1, table 6.2.3-5)

 ptrs-Power ENUMERATED {p00, p01, p10, p11}

 },

 -- Configuration of UL PTRS for DFT-S-OFDM.

 dft-S-OFDM SEQUENCE {

 -- Sample density of PT-RS for DFT-s-OFDM, pre-DFT, indicating a set of thresholds T={NRBn,n=0,1,2,3,4},

 -- that indicates dependency between presence of PT-RS and scheduled BW and the values of X and K the UE should

 -- use depending on the scheduled BW according to the table in 38.214 FFS\_Section.

 -- Corresponds to L1 parameter 'UL-PTRS-pre-DFT-density' (see 38.214, section 6.1, 6.2.3-3)

 **sampleDensity SEQUENCE (SIZE (5)) OF INTEGER (1..276), OPTIONAL, --**

 -- Time density (OFDM symbol level) of PT-RS for DFT-s-OFDM. If the value is absent, the UE applies value d1.

 -- Corresponds to L1 parameter 'UL-PTRS-time-density-transform-precoding' (see 38.214, section 6.1)

 timeDensity ENUMERATED {d2} OPTIONAL -- Need S

 **MCS\_Enable BOOLEAN OPTIONAL**

 **}**

 } OPTIONAL, -- Cond M

 ...

}

-- TAG-PTRS-UPLINKCONFIG-STOP

-- ASN1STOP

# Fast SRS precoding

Documents effected

1. 38.331
2. 38.214

38.214

6.1.1.2 Non-Codebook based UL transmission

For non-codebook based transmission, the UE can determine its PUSCH precoder and transmission rank based on the wideband SRI when multiple SRS resources are configured, where the SRI is given by the SRS resource indicator in DCI according to subclause 7.3.1.1.2 of [5, 38.212], or the SRI is given by *srs-ResourceIndicator* according to subclause 6.1.2.3. The UE shall use one or multiple SRS resources for SRS transmission, where the number of SRS resources which can be configured to the UE for simultaneously transmission in the same RBs is a UE capability. Only one SRS port for each SRS resource is configured. Only one SRS resource set can be configured with higher layer parameter *usage* in *SRS-ResourceSet* set to 'nonCodebook'. The maximum number of SRS resources that can be configured for non-codebook based uplink transmission is 4. The indicated SRI in slot *n* is associated with the most recent transmission of SRS resource identified by the SRI, where the SRS resource is prior to the PDCCH carrying the SRI before slot *n*.

For non-codebook based transmission, the UE can calculate the precoder used for the transmission of precoded SRS based on measurement of an associated NZP CSI-RS resource. A UE can be configured with only one NZP CSI-RS resource for the SRS resource set with higher layer parameter usage in *SRS-ResourceSet* set to 'nonCodebook'.

- If aperiodic SRS resource set is configured, the associated NZP-CSI-RS for UL channel measurement is indicated via SRS request field in DCI format 0\_1 and 1\_1, where *AperiodicSRS-ResourceTrigger* (indicating the association among aperiodic SRS triggering state), triggered SRS resource(s) *srs-ResourceSetId*, *csi-RS (*indicating the associated *NZP-CSI-RS-ResourceId* for UL channel measurement*)* are higher layer configured in *SRS-ResourceSet*. A UE is not expected to update the SRS precoding information if the gap from the last symbol of the reception of the aperiodic NZP-CSI-RS resource and the first symbol of the aperiodic SRS transmission including the effect of timing advance is less than SRS Precoding Configuration Delay~~42~~ OFDM symbols. If *srs-precoding-delay* in *SRS-Config* is configured by higher layer to low, then SRS Precoding Configuration Delay is given as in Table 6.1.1.2-1 else it is 42 OFDM symbols.

- If the UE configured with aperiodic SRS associated with aperiodic NZP CSI-RS resource, the presence of the associated CSI-RS is indicated by the SRS request field if the value of the SRS request field is not '00' as in Table 7.3.1.1.2-24 of [5, TS 38.212]. The CSI-RS is located in the same slot as the SRS request field, while any of the *tci-States* for aperiodic CSI-RS shall not be configured with 'QCL-Type-D'.

- If periodic or semi-persistent SRS resource set is configured, the *NZP-CSI-RS-ResourceConfigID* for measurement is indicated via higher layer parameter *associatedCSI-RS* in *SRS-ResourceSet*.

Table 6.1.1.2-1: SRS Precoding Configuration Delay

|  |  |
| --- | --- |
| µ | Delay in number of OFDM symbols |
| 0 | 4 |
| 1 | 7 |
| 2 | 14 |
| 3 | 29 |

38.331

SRS-ResourceSet ::= SEQUENCE {

 srs-ResourceSetId SRS-ResourceSetId,

 srs-ResourceIdList SEQUENCE (SIZE(1..maxNrofSRS-ResourcesPerSet)) OF SRS-ResourceId OPTIONAL, -- Cond Setup

 resourceType CHOICE {

 aperiodic SEQUENCE {

 aperiodicSRS-ResourceTrigger INTEGER (1..maxNrofSRS-TriggerStates-1),

 csi-RS NZP-CSI-RS-ResourceId OPTIONAL, -- Cond NonCodebook

 slotOffset INTEGER (1..32) OPTIONAL, -- Need S

srs-precoding-delay INTEGER(0..1) OPTIONAL,

 ...

 },

 semi-persistent SEQUENCE {

 associatedCSI-RS NZP-CSI-RS-ResourceId OPTIONAL, -- Cond NonCodebook

 ...

 },

 periodic SEQUENCE {

 associatedCSI-RS NZP-CSI-RS-ResourceId OPTIONAL, -- Cond NonCodebook

 ...

 }

 },

|  |
| --- |
| *SRS-Resource field descriptions* |
| ***srs-precoding-delay*** If the field value is low (0), then the precoding delays are considered from the table (see 38.214, section 6.1.1.2) |
| ***cyclicShift-n2***Cyclic shift configuration. Corresponds to L1 parameter 'SRS-CyclicShiftConfig' (see 38.214, section 6.2.1) |
| ***cyclicShift-n4***Cyclic shift configuration. Corresponds to L1 parameter 'SRS-CyclicShiftConfig' (see 38.214, section 6.2.1) |

# Precoding for pi/2 BPSK waveform and other enhancements

In this section, we describe the list of changes submitted over and top of the 15.3 version of the 3GPP 5G NR 38 series specifications.

The list of changes includes modifications to the following specifications –

1. 38211 (RAN1)
2. 38213 (RAN1)
3. 38306 (RAN2)
4. 38331(RAN2)
5. 38101-1(RAN4)
6. 38101-2(RAN4)

**The section numbers and the content changed are mentioned below. The modified content is highlighted in red color.**

**38.211**

#### 6.3.1.4 Transform precoding

If transform precoding is not enabled according to 6.1.3 of [6, TS38.214], for each layer .

If transform precoding is enabled according to 6.1.3 of [6, TS38.214], and depends on the configuration of phase-tracking reference signals.

If the procedure in [6, TS 38.214] indicates that phase-tracking reference signals are not being used, the block of complex-valued symbols for the single layer shall be divided into sets, each corresponding to one OFDM symbol and .

If the procedure in [6, TS 38.214] indicates that phase-tracking reference signals are being used, the block of complex-valued symbols shall be divided into sets, each set corresponding to one OFDM symbol, and where set contains symbols and is mapped to the complex-valued symbols corresponding to OFDM symbol prior to transform precoding, with and . The index of PT-RS samples in set , the number of samples per PT-RS group , and the number of PT-RS groups are defined in clause 6.4.1.2.2.2. The quantity when OFDM symbol contains one or more PT-RS samples, otherwise .

When π/2-BPSK is enabled for PUCCH/PUSCH transmission by higher layer parameters, the complex valued symbols, the complex-valued symbols are precoded to create new symbols , and the transform precoding shall be applied according to

resulting in a block of complex-valued symbols . The variable, where represents the bandwidth of the PUSCH in terms of resource blocks, and shall fulfil

 

where is a set of non-negative integers.

For other modulation schemes, i.e., when π/2-BPSK is not enabled for PUCCH/PUSCH transmission by higher layer parameters transform precoding shall be applied according to

 

resulting in a block of complex-valued symbols . The variable, where  represents the bandwidth of the PUSCH in terms of resource blocks, and shall fulfil

 

where  is a set of non-negative integers.

#### 6.4.1.1.1.2 Sequence generation when transform precoding is enabled

If transform precoding for PUSCH is enabled, the reference-signal sequence shall be generated according to

where is given by clause 5.2.2 with and for a PUSCH transmission dynamically scheduled by DCI.

The sequence group , where  is given by

- if is configured by the higher-layer parameter *nPUSCH-Identity* in the *DMRS-UplinkConfig* IE and the PUSCH is not a msg3 PUSCH according to clause 8.3 in [5, TS 38.213].

- otherwise

where  and the sequence number are given by:

- if neither group, nor sequence hopping shall be used

 

- if group hopping but not sequence hopping shall be used

 

 where the pseudo-random sequence is defined by clause 5.2.1 and shall be initialized with  at the beginning of each radio frame

- if sequence hopping but not group hopping shall be used

 

 where the pseudo-random sequence is defined by clause 5.2.1 and shall be initialized with  at the beginning of each radio frame

The quantity above is the OFDM symbol number except for the case of double-symbol DMRS in which case is the OFDM symbol number of the first symbol of the double-symbol DMRS.

If transform precoding is enabled according to 6.1.3 of [6, TS38.214], and when π/2-BPSK is enabled for PUSCH transmission by higher layer parameters, the reference signals remain un-filtered and is configurable to adjust the relative power level of the reference signal with respect to the PUSCH data. For other modulation schemes, .

##### 6.4.1.3.3 Demodulation reference signal for PUCCH formats 3 and 4

###### 6.4.1.3.3.1 Sequence generation

The reference-signal sequence shall be generated according to

where is given by clause 6.3.2.6.3 and is given by clause 6.3.2.2.

The cyclic shift varies with the symbol number and slot number according to clause 6.3.2.2.2 with  for PUCCH format 3 and obtained from Table 6.4.1.3.3.1-1 with the orthogonal sequence index given by clause 6.3.2.6.3 for PUCCH format 4.

If transform precoding is enabled according to 6.1.3 of [6, TS38.214], and when π/2-BPSK is enabled for PUCCH format 3 and 4 transmission by higher layer parameters, the reference signals remain un-filtered and is configurable. For other modulation schemes,

**38.213**

##### 9.2.2 PUCCH Formats for UCI transmission

…..

A number of DMRS symbols for a PUCCH transmission using PUCCH format 3 or 4 is provided by higher layer parameter *additionalDMRS*.

/2-PBSK is used, instead of QPSK, for a PUCCH transmission using PUCCH format 3 or 4 if higher layer parameter *pi2BPSK* is enabled.

**38.214**

##### 6.1.4.1 Modulation order and target code rate determination

…..

For Table 6.1.4.1-1 and Table 6.1.4.1-2, if higher layer parameter *PUSCH-tp-pi2BPSK* is enabled, *q* = 1 otherwise *q*=2.

**38.306**

The support for pi2BPSK modulation for PUCCH and PUSCH is made mandatory for both FR1 and FR2 bands,

| ***Definitions for parameters*** | Per | M | FDDTDDDIFF | FR1FR2DIFF |
| --- | --- | --- | --- | --- |
| ***pucch-F3-4-HalfPi-BPSK***Indicates whether the UE supports pi/2-BPSK for PUCCH format 3/4. | UE | **Yes** | No | No |
| ***pusch-HalfPi-BPSK******Indicates whether the UE supports pi/2-BPSK for PUSCH.***  | UE | **Yes** | No | No |

**38.331**

Earlier it was optional and only if the field is present, then the UE depending on the capability it is used. Now the parameter pi2BPSK is made mandatory.

*PUCCH-Config*

The IE *PUCCH-Config* is used to configure UE specific PUCCH parameters (per BWP).

***PUCCH-Config* information element**

-- ASN1START

-- TAG-PUCCH-CONFIG-START

PUCCH-Config ::= SEQUENCE {

 resourceSetToAddModList SEQUENCE (SIZE (1..maxNrofPUCCH-ResourceSets)) OF PUCCH-ResourceSet OPTIONAL, -- Need N

 resourceSetToReleaseList SEQUENCE (SIZE (1..maxNrofPUCCH-ResourceSets)) OF PUCCH-ResourceSetId OPTIONAL, -- Need N

 resourceToAddModList SEQUENCE (SIZE (1..maxNrofPUCCH-Resources)) OF PUCCH-Resource OPTIONAL, -- Need N

 resourceToReleaseList SEQUENCE (SIZE (1..maxNrofPUCCH-Resources)) OF PUCCH-ResourceId OPTIONAL, -- Need N

 format1 SetupRelease { PUCCH-FormatConfig } OPTIONAL, -- Need M

 format2 SetupRelease { PUCCH-FormatConfig } OPTIONAL, -- Need M

 format3 SetupRelease { PUCCH-FormatConfig } OPTIONAL, -- Need M

 format4 SetupRelease { PUCCH-FormatConfig } OPTIONAL, -- Need M

 schedulingRequestResourceToAddModList SEQUENCE (SIZE (1..maxNrofSR-Resources)) OF SchedulingRequestResourceConfig OPTIONAL, -- Need N

 schedulingRequestResourceToReleaseList SEQUENCE (SIZE (1..maxNrofSR-Resources)) OF SchedulingRequestResourceId OPTIONAL, -- Need N

 multi-CSI-PUCCH-ResourceList SEQUENCE (SIZE (1..2)) OF PUCCH-ResourceId OPTIONAL,-- Need M

 dl-DataToUL-ACK SEQUENCE (SIZE (1..8)) OF INTEGER (0..15) OPTIONAL, -- Need M

 spatialRelationInfoToAddModList SEQUENCE (SIZE (1..maxNrofSpatialRelationInfos)) OF PUCCH-SpatialRelationInfo OPTIONAL, -- Need N

 spatialRelationInfoToReleaseList SEQUENCE (SIZE (1..maxNrofSpatialRelationInfos)) OF PUCCH-SpatialRelationInfoId OPTIONAL, -- Need N

 pucch-PowerControl PUCCH-PowerControl OPTIONAL, -- Need M

 ...

}

PUCCH-FormatConfig ::= SEQUENCE {

 interslotFrequencyHopping ENUMERATED {enabled} OPTIONAL, -- Need R

 additionalDMRS ENUMERATED {true} OPTIONAL, -- Need R

 maxCodeRate PUCCH-MaxCodeRate OPTIONAL, -- Need R

 nrofSlots ENUMERATED {n2,n4,n8} OPTIONAL, -- Need S

 pi2BPSK ENUMERATED {enabled},

 simultaneousHARQ-ACK-CSI ENUMERATED {true} OPTIONAL -- Need R

}

………

Similar to PUCCH, even for PUSCH pi2BPSK is made mandatory.

*PUSCH-Config*

The IE *PUSCH-Config* is used to configure the UE specific PUSCH parameters applicable to a particular BWP.

***PUSCH-Config* information element**

-- ASN1START

-- TAG-PUSCH-CONFIG-START

PUSCH-Config ::= SEQUENCE {

 dataScramblingIdentityPUSCH INTEGER (0..1023) OPTIONAL, -- Need S

 txConfig ENUMERATED {codebook, nonCodebook} OPTIONAL, -- Need S

 dmrs-UplinkForPUSCH-MappingTypeA SetupRelease { DMRS-UplinkConfig } OPTIONAL, -- Need M

 dmrs-UplinkForPUSCH-MappingTypeB SetupRelease { DMRS-UplinkConfig } OPTIONAL, -- Need M

 pusch-PowerControl PUSCH-PowerControl OPTIONAL, -- Need M

 frequencyHopping ENUMERATED {intraSlot, interSlot} OPTIONAL, -- Need S

 frequencyHoppingOffsetLists SEQUENCE (SIZE (1..4)) OF INTEGER (1.. maxNrofPhysicalResourceBlocks-1) OPTIONAL, -- Need M

 resourceAllocation ENUMERATED { resourceAllocationType0, resourceAllocationType1, dynamicSwitch},

 pusch-TimeDomainAllocationList SetupRelease { PUSCH-TimeDomainResourceAllocationList } OPTIONAL, -- Need M

 pusch-AggregationFactor ENUMERATED { n2, n4, n8 } OPTIONAL, -- Need S

 mcs-Table ENUMERATED {qam256, qam64LowSE} OPTIONAL, -- Need S

 mcs-TableTransformPrecoder ENUMERATED {qam256, qam64LowSE} OPTIONAL, -- Need S

 transformPrecoder ENUMERATED {enabled, disabled} OPTIONAL, -- Need S

 codebookSubset ENUMERATED {fullyAndPartialAndNonCoherent, partialAndNonCoherent,

 nonCoherent} OPTIONAL, -- Cond codebookBased

 maxRank INTEGER (1..4) OPTIONAL, -- Cond codebookBased

 rbg-Size ENUMERATED { config2} OPTIONAL, -- Need S

 uci-OnPUSCH SetupRelease { UCI-OnPUSCH} OPTIONAL, -- Need M

 tp-pi2BPSK ENUMERATED {enabled},

 ...

}

UCI-OnPUSCH ::= SEQUENCE {

 betaOffsets CHOICE {

 dynamic SEQUENCE (SIZE (4)) OF BetaOffsets,

 semiStatic BetaOffsets

 } OPTIONAL, -- Need M

 scaling ENUMERATED { f0p5, f0p65, f0p8, f1 }

}

-- TAG-PUSCH-CONFIG-STOP

-- ASN1STOP

*Phy-Parameters*

The IE *Phy-Parameters* is used to convey the physical layer capabilities.

*Phy-Parameters* information element

-- ASN1START

-- TAG-PHY-PARAMETERS-START

Phy-Parameters ::= SEQUENCE {

…..

Phy-ParametersFRX-Diff ::= SEQUENCE {

…….

 twoDifferentTPC-Loop-PUCCH ENUMERATED {supported} OPTIONAL,

 pusch-HalfPi-BPSK ENUMERATED {supported},

 pucch-F3-4-HalfPi-BPSK ENUMERATED {supported},

 almostContiguousCP-OFDM-UL ENUMERATED {supported} OPTIONAL,

 sp-CSI-RS ENUMERATED {supported} OPTIONAL,

 sp-CSI-IM ENUMERATED {supported} OPTIONAL,

 tdd-MultiDL-UL-SwitchPerSlot ENUMERATED {supported} OPTIONAL,

 multipleCORESET ENUMERATED {supported} OPTIONAL,

 ...

}

**38.101-1**

### 6.2.2 UE maximum output power reduction

UE is allowed to reduce the maximum output power due to higher order modulations and transmit bandwidth configurations. For UE Power Class [2] and 3, the allowed maximum power reduction (MPR) is defined in Table 6.2.2-2 and Table 6.2.2-1, respectively for channel bandwidths that meets both following criteria:

Channel bandwidth ≤ 100MHz.

Relative channel bandwidth ≤ 4% for TDD bands and ≤ 3% for FDD bands

Where relative channel bandwith = 2\*BWChannel / (FUL\_low + FUL\_high)

Table 6.2.2-1 Maximum power reduction (MPR) for power class 3

|  |  |  |
| --- | --- | --- |
| Modulation |  | MPR (dB) |
| Edge RB allocations | Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM PI/2 BPSK | ≤3.51 | ≤ 1.21 | ≤0.21 |
| 0.52 | 0.52 | 02 |
| DFT-s-OFDM QPSK | ≤ 1 | 0 |
| DFT-s-OFDM 16 QAM | ≤ 2 | ≤ 1 |
| DFT-s-OFDM 64 QAM | ≤ 2.5 |
| DFT-s-OFDM 256 QAM | 4.5 |
| CP-OFDM QPSK | ≤ 3 | ≤ 1.5 |
| CP-OFDM 16 QAM | ≤ 3 | ≤ 2 |
| CP-OFDM 64 QAM | ≤ 3.5 |
| CP-OFDM 256 QAM | ≤ 6.5 |
| NOTE 1: Applicable for UE operating in TDD mode with PI/2 PBSK modulation and 40% or less slots in radio frame are used for UL transmission for bands n40, n77, n78 and n79.NOTE 2: Applicable for UE operating in FDD mode, or in TDD mode in bands other than n40, n77, n78 and n79 and if more than 40% of slots in radio frame are used for UL transmission for bands n40, n77, n78 and n79.  |

### 6.2.4 Configured transmitted power

The UE is allowed to set its configured maximum output power PCMAX,f,c for carrier f of serving cell c in each slot. The configured maximum output power PCMAX,f,c is set within the following bounds:

PCMAX\_L,f,c ≤ PCMAX,f,c ≤ PCMAX\_H,f,c with

 PCMAX\_L,f,c = MIN {PEMAX,c– ∆TC,c, (PPowerClass – ΔPPowerClass) – MAX(MPRc + A-MPRc+ ΔTIB,c + ∆TC,c +∆TRxSRS, P-MPRc) }

PCMAX\_H,f,c = MIN {PEMAX,c, PPowerClass – ΔPPowerClass }

where

PEMAX,c is the value given by IE P-Max for serving cell c, defined in TS 38.331[7];

PPowerClass is the maximum UE power specified in Table 6.2.1-1 without taking into account the tolerance specified in the Table 6.2.1-1;

PEMAX,c is increased by +3 dB for a power class 3 capable UE operating in TDD bands n40, n77, n78, and n79 with PI/2 BPSK modulation and 40% or less slots in radio frame are used for UL transmission when PEMAX,c ≥ 20 dBm.

ΔPPowerClass = -3 dB for a power class 3 capable UE operating in TDD bands n40, n77, n78, and n79 with PI/2 BPSK modulation and 40% or less slots in radio frame are used for UL transmission.

##### 6.4.2.4.1 Requirements for pi/2 BPSK modulation

These requirements apply if the IE [P-Boost-BPSK] is set to 1 for power class 3 capable UE operating in TDD bands n40, n77, n78 and n79 with pi/2 BPSK modulation and 40% or less slots in radio frame are used for UL transmission. Otherwise the requirements for EVM equalizer spectrum flatness defined in clause 6.4.2.4 apply.

The EVM equalizer coefficients across the allocated uplink block shall be modified to fit inside the mask specified in Table 6.4.2.4.1-1 for normal conditions, prior to the calculation of EVM.

Table 6.4.2.4.1-1: Mask for EVM equalizer coefficients for pi/2 BPSK, normal conditions

|  |  |  |
| --- | --- | --- |
| Frequency range | Parameter  | Maximum ripple [dB] |
| F\_meas – F\_center ≤ X MHz or F\_center – F\_meas ≤ X MHz (Range 1) | X1 | 6 (p-p) |
| F\_meas – F\_center > X MHz or F\_center – F\_meas > X MHz (Range 2) | X2 | 14 (p-p) |
| NOTE 1: F\_meas refers to the sub-carrier frequency for which the equalizer coefficient is evaluatedNOTE 2: F\_center refers to the center frequency of an allocated block of PRBsNOTE 3: X, in MHz, is equal to 25% of the bandwidth of the PRB allocationNOTE 4: See Figure 6.4.2.4-1 for description of X1, X2 |



Figure 6.4.2.4.1-1: The limits for EVM equalizer spectral flatness with the maximum allowed variation. F\_center denotes the center frequency of the allocated block of PRBs. F\_alloc denotes the bandwidth of the PRB allocation.

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#### 6.2.2.3 UE maximum output power reduction for power class 3

For power class 3 the MPR is defined in Table 6.2.2.3-1.

Table 6.2.2.3-1 MPR for power class 3

|  |  |  |
| --- | --- | --- |
|  |  | Channel Bandwidth / MPR |
|  |  | 50 / 100 / 200 MHz | 400 MHz |
| DFT-s-OFDM | Pi/2 BPSK | 0.5 | 2.0 |
| QPSK | 1.5 | 3.0 |
| 16QAM | 3 | 4.5 |
| 64QAM | 5 | 6.5 |
| CP-OFDM | QPSK | 3.5 | 5.0 |
| 16QAM | 5 | 6.5 |
| 64QAM | 7.5 | 9.0 |

The waveform defined by BW = 100MHz, SCS=60KHz, DFT-S-OFDM QPSK, 128RB0 is the reference waveform with 0 dB MPR and is used for the power class definition.

UE requirements for the waveform defined by BW = 100MHz, SCS=60KHz, DFT-S-OFDM pi/2 BPSK, 128RB0 is 0 dB MPR.

#### 6.4.2.5 EVM spectral flatness for pi/2 BPSK modulation with spectrum shaping

These requirements are defined for pi/2 BPSK modulation. The EVM equalizer coefficients across the allocated uplink block shall be modified to fit inside the mask specified in Table 6.4.2.5-1 for normal conditions, prior to the calculation of EVM. The limiting mask shall be placed to minimize the change in equalizer coefficients in a sum of squares sense.

Table 6.4.2.5-1: Mask for EVM equalizer coefficients for pi/2 BPSK with spectrum shaping, normal conditions

|  |  |  |
| --- | --- | --- |
| Frequency range | Parameter  | Maximum ripple (dB) |
| F\_meas – F\_center ≤ X MHz or F\_center – F\_meas ≤ X MHz(Range 1) | X1 | 6 (p-p) |
| F\_meas – F\_center > X MHz or F\_center – F\_meas < X MHz(Range 2) | X2 | 14 (p-p) |
| NOTE 1: F\_meas refers to the sub-carrier frequency for which the equalizer coefficient is evaluatedNOTE 2: F\_center refers to the center frequency of an allocated block of PRBsNOTE 3: X, in MHz, is equal to 25% of the bandwidth of the PRB allocationNOTE 4: See Figure 6.4.2.5-1 for description of X1, X2 and X3 |



Figure 6.4.2.5-1: The limits for EVM equalizer spectral flatness with the maximum allowed variation. F\_center denotes the center frequency of the allocated block of PRBs. F\_alloc denotes the bandwidth of the PRB allocation.