**3GPP TSG- Meeting #**

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| *CR-Form-v12.1* | | | | | | | | |
| **DRAFT CHANGE REQUEST** | | | | | | | | |
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|  |  | **CR** |  | **rev** |  | **Current version:** |  |  |
|  | | | | | | | | |
| *For* [***HELP***](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:*** |  | | | | | | | | | |
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| ***Source to WG:*** |  | | | | | | | | | |
| ***Source to TSG:*** |  | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** |  | | | | |  | ***Date:*** | | | 2021-11-01 |
|  |  | | | |  | |  | | |  |
| ***Category:*** |  |  | | | | | ***Release:*** | | |  |
|  | *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-15 (Release 15) Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | Introduction of additional enhancements for NB-IoT. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Support for NB-IoT features according to RAN1 agreements:  - 16QAM for unicast in uplink and downlink | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | No support of additional enhancements for NB-IoT. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 16.2.1.1.1, 16.2.2, 16.4.1.3, 16.4.1.5, 16.4.1.5.1, 16.5.1.1, 16.5.1.2 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | | **x** |  | Other core specifications | | | | TS 36.211, TS 36.212 | | |
| ***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 parts are omitted>

## 16.2 Power control

### 16.2.1 Uplink power control

Uplink power control controls the transmit power of the different uplink physical channels.

#### 16.2.1.1 Narrowband physical uplink shared channel

##### 16.2.1.1.1 UE behaviour

The setting of the UE Transmit power for a Narrowband Physical Uplink Shared Channel (NPUSCH) transmission is defined as follows. For FDD, if the UE is capable of enhanced random access power control [12], and it is configured by higher layers, and for TDD, enhanced random access power control shall be applied for a UE which started the random access procedure in the first or second configured NPRACH repetition level.

The UE transmit power  for NPUSCH transmission in NB-IoT UL slot *i* for the serving cell is given by:

For NPUSCH (re)transmissions corresponding to the random access response grant if enhanced random access power control is not applied, and for all other NPUSCH transmissions except for NPUSCH (re)transmission corresponding to preconfigured uplink resource, when the number of repetitions of the allocated NPUSCH RUs is greater than 2:

[dBm]

otherwise

[dBm]

where,

- is the configured UE transmit power defined in [6] in NB-IoT UL slot *i* for serving cell .



- is the NPUSCH transmission resource bandwidth normalized by 15 kHz, where {1/4} is used for 3.75 kHz subcarrier spacing and {1, 3, 6, 12} are used for 15kHz subcarrier spacing

- is a parameter composed of the sum of a component  provided from higher layers and a component  provided by higher layers for *j=1*, *3* andfor serving cell where . For NPUSCH (re)transmissions corresponding to a dynamic scheduled grant or a semi-persistent grant then *j=1*, for NPUSCH (re)transmissions corresponding to the random access response grant then *j=2* and for NPUSCH transmission using preconfigured uplink resource then *j=3*. . If enhanced random access power control is not applied, , where the parameter *preambleInitialReceivedTargetPower* [8] () and are signalled from higher layers for serving cell . If enhanced random access power control is applied,



- For *j*=*1*, for NPUSCH format 2, =1; for NPUSCH format 1, is provided by higher layers for serving cell. For *j*=2, For *j*=*3*,  is the parameter *alpha* in *PUR-Config-NB* provided by higher layers for serving cell.



-  is the downlink path loss estimate calculated in the UE for serving cell  in dB and  = *nrs-Power* + *nrs-PowerOffsetNonAnchor* – NRSRP, where *nrs-Power* is provided by higher layers and Clause 16.2.2, and *nrs-PowerOffsetNonAnchor* is set to zero if it is not provided by higher layers and NRSRP is defined in [5] for serving cell .

- If NPUSCH (re)transmissions with 16QAM,

- for and for where  is given by the parameter *deltaMCS-Enabled* provided by higher layers for serving cell , and

where is the code block size and is the number of resource elements determined as where , , are defined in [3], and is defined in section 16.5.1.1

- otherwise .

<Unchanged parts are omitted>

### 16.2.2 Downlink power allocation

The eNodeB determines the downlink transmit energy per resource element.

For an NB-IoT cell, the UE may assume NRS EPRE is constant across the downlink NB-IoT system bandwidth and constant across all subframes that contain NRS, until different NRS power information is received.

The downlink NRS EPRE can be derived from the downlink narrowband reference-signal transmit power given by *nrs-Power* + *nrs-PowerOffsetNonAnchor,* where the parameter *nrs-Power* is provided by higher layers and *nrs-PowerOffsetNonAnchor* is zero if it is not provided by higher layers. The downlink narrowband reference-signal transmit power is defined as the linear average over the power contributions (in [W]) of all resource elements that carry narrowband reference signals within the operating NB-IoT system bandwidth.

A UE may assume that the ratio of NWUS EPRE to NRS EPRE is 0 dB.

A UE may assume the ratio of NPDSCH EPRE to NRS EPRE among NPDSCH REs (not applicable to NPDSCH REs with zero EPRE) is 0 dB for an NB-IoT cell with one NRS antenna port and -3 dB for an NB-IoT cell with two NRS antenna ports if higher layer parameter *nrs-PowerRatio* is not configured.

If a UE is configured with higher layer parameters *npdsch-16QAM-Config* and *nrs-PowerRatio*,

- if higher layer parameter *operationModeInfo* indicates '10' or '11',

- the UE may assume the downlink transmit power, defined as the linear average over the power contributions (in [W]) of all resource elements within the operating NB-IoT system bandwidth, is constant across all symbols and subframes, and

- the ratio of NPDSCH EPRE to NRS EPRE among NPDSCH REs (not applicable to NPDSCH REs with zero EPRE) is given by the parameter *nrs-PowerRatio* in symbols without NRS

- otherwise,

- the UE may assume the downlink transmit power, defined as the linear average over the power contributions (in [W]) of all resource elements within the operating NB-IoT system bandwidth, is constant across all symbols (except symbols with CRS) and subframes,

- the ratio of NPDSCH EPRE to NRS EPRE among NPDSCH REs (not applicable to NPDSCH REs with zero EPRE) is given by the parameter *nrs-PowerRatio* in symbols without NRS and CRS, and

- the ratio of NPDSCH EPRE to NRS EPRE among NPDSCH REs (not applicable to NPDSCH REs with zero EPRE) is given by the parameter *nrs-PowerRatioWithCRS* in symbols with CRS.

A UE may assume the ratio of NPBCH EPRE to NRS EPRE among NPBCH REs (not applicable to NPBCH REs with zero EPRE) is 0 dB for an NB-IoT cell with one NRS antenna port and -3 dB for an NB-IoT cell with two NRS antenna ports.

A UE may assume the ratio of NPDCCH EPRE to NRS EPRE among NPDCCH REs (not applicable to NPDCCH REs with zero EPRE) is 0 dB for an NB-IoT cell with one NRS antenna port and -3 dB for an NB-IoT cell with two NRS antenna ports.

If higher layer parameter *operationModeInfo* indicates '00' or *samePCI-Indicator* indicates '*samePCI*' for a cell, the ratio of NRS EPRE to CRS EPRE is given by the parameter *nrs-CRS-PowerOffset* if the parameter *nrs-CRS-PowerOffset* is provided by higher layers, and the ratio of NRS EPRE to CRS EPRE may be assumed to be 0 dB if the parameter *nrs-CRS-PowerOffset* is not provided by higher layers. If *nrs-CRS-PowerOffset* is provided by higher layers and is a non-integer value, the value of *nrs-Power* is 0.23 dBm higher than indicated.

<Unchanged parts are omitted>

#### 16.4.1.3 Resource allocation

The resource allocation information in DCI format N1, N2 (paging) for NPDSCH indicates to a scheduled UE

- a number of subframes () determined by the resource assignment field () in the corresponding DCI according to Table 16.4.1.3-1.

- a repetition number () determined by the repetition number field () in the corresponding DCI according to Table 16.4.1.3-2. For NPDSCH with 16QAM, .

Table 16.4.1.3-1: Number of subframes () for NPDSCH.

|  |  |
| --- | --- |
|  |  |
| 0 | 1 |
| 1 | 2 |
| 2 | 3 |
| 3 | 4 |
| 4 | 5 |
| 5 | 6 |
| 6 | 8 |
| 7 | 10 |

Table 16.4.1.3-2: Number of repetitions () for NPDSCH.

|  |  |
| --- | --- |
|  |  |
| 0 | 1 |
| 1 | 2 |
| 2 | 4 |
| 3 | 8 |
| 4 | 16 |
| 5 | 32 |
| 6 | 64 |
| 7 | 128 |
| 8 | 192 |
| 9 | 256 |
| 10 | 384 |
| 11 | 512 |
| 12 | 768 |
| 13 | 1024 |
| 14 | 1536 |
| 15 | 2048 |

For FDD, the number of repetitions for the NPDSCH carrying *SystemInformationBlockType1-NB* is determined based on the parameter *schedulingInfoSIB1* configured by higher-layersand according to Table 16.4.1.3-3.

Table 16.4.1.3-3: Number of repetitions for NPDSCH carrying *SystemInformationBlockType1-NB*, FDD.

|  |  |
| --- | --- |
| **Value of *schedulingInfoSIB1*** | **Number of NPDSCH repetitions** |
| 0 | 4 |
| 1 | 8 |
| 2 | 16 |
| 3 | 4 |
| 4 | 8 |
| 5 | 16 |
| 6 | 4 |
| 7 | 8 |
| 8 | 16 |
| 9 | 4 |
| 10 | 8 |
| 11 | 16 |
| 12-15 | Reserved |

For FDD, the starting radio frame for the first transmission of the NPDSCH carrying *SystemInformationBlockType1-NB* is determined according to Table 16.4.1.3-4.

Table 16.4.1.3-4: Starting radio frame for the first transmission of the NPDSCH carrying *SystemInformationBlockType1-NB*, FDD.

|  |  |  |
| --- | --- | --- |
| **Number of NPDSCH repetitions** |  | **Starting radio frame number for** *SystemInformationBlockType1-NB* **repetitions (*nf mod 256*)** |
| 4 | mod 4 = 0 | 0 |
| mod 4 = 1 | 16 |
| mod 4 = 2 | 32 |
| mod 4 = 3 | 48 |
| 8 | mod 2 = 0 | 0 |
| mod 2 = 1 | 16 |
| 16 | mod 2 = 0 | 0 |
| mod 2 = 1 | 1 |

For the TDD NB-IoT carrier on which NPSS/NSSS/NPBCH are detected, the number of repetitions and subframe index for the NPDSCH carrying *SystemInformationBlockType1-NB* is determined based on the parameter *schedulingInfoSIB1* configured by higher-layersand according to Table 16.4.1.3-5.

Table 16.4.1.3-5: Number of repetitions and subframe index for NPDSCH carrying *SystemInformationBlockType1-NB*, TDD.

|  |  |  |
| --- | --- | --- |
| **Value of *schedulingInfoSIB1*** | **Number of NPDSCH repetitions** | **Subframe index** |
| 0 | 4 | 0 |
| 1 | 8 | 0 |
| 2 | 16 | 0 |
| 3 | 4 | 0 |
| 4 | 8 | 0 |
| 5 | 16 | 0 |
| 6 | 4 | 0 |
| 7 | 8 | 0 |
| 8 | 16 | 0 |
| 9 | 4 | 0 |
| 10 | 8 | 0 |
| 11 | 16 | 0 |
| 12-15 | 16 | 4 |

For the TDD NB-IoT carrier on which NPSS/NSSS/NPBCH are detected, the starting radio frame for the first transmission of the NPDSCH carrying *SystemInformationBlockType1-NB* is determined according to Table 16.4.1.3-6.

Table 16.4.1.3-6: Starting radio frame for the first transmission of the NPDSCH carrying *SystemInformationBlockType1-NB*, TDD.

|  |  |  |  |
| --- | --- | --- | --- |
| **Subframe index** | **Number of NPDSCH repetitions** |  | **Starting radio frame number for** *SystemInformationBlockType1-NB* **repetitions (*nf mod 256*)** |
| 0 | 4 | mod 4 = 0 | 1 |
| mod 4 = 1 | 17 |
| mod 4 = 2 | 33 |
| mod 4 = 3 | 49 |
| 0 | 8 | mod 2 = 0 | 1 |
| mod 2 = 1 | 17 |
| 0 | 16 | Any | ***nf* mod256**= 1 |
| 4 | 16 | mod 2 = 0 | ***nf* mod256**= 0 |
| mod 2 = 1 | ***nf* mod256**= 1 |

For a higher layer configured TDD NB-IoT carrier, the number of repetitions and subframe index for the NPDSCH carrying *SystemInformationBlockType1-NB* is determined based on the parameter *schedulingInfoSIB1* configured by higher-layersand according to Table 16.4.1.3-7.

Table 16.4.1.3-7: Number of repetitions and subframe index for NPDSCH carrying *SystemInformationBlockType1-NB*, TDD.

|  |  |  |
| --- | --- | --- |
| **Value of *schedulingInfoSIB1*** | **Number of NPDSCH repetitions** | **Subframe index** |
| 0 | 8 | 0, 5 |
| 1 | 16 | 0, 5 |
| 2 | 8 | 0, 5 |
| 3 | 16 | 0, 5 |
| 4 | 8 | 0, 5 |
| 5 | 16 | 0, 5 |
| 6 | 8 | 0, 5 |
| 7 | 16 | 0, 5 |

For a higher layer configured TDD NB-IoT carrier, the starting radio frame for the first transmission of the NPDSCH carrying *SystemInformationBlockType1-NB* is determined according to Table 16.4.1.3-8.

Table 16.4.1.3-8: Starting radio frame for the first transmission of the NPDSCH carrying *SystemInformationBlockType1-NB*, TDD.

|  |  |  |
| --- | --- | --- |
| **Number of NPDSCH repetitions** |  | **Starting radio frame number for** *SystemInformationBlockType1-NB* **repetitions (*nf mod 256*)** |
| 8 | mod 2 = 0 | 0 |
| mod 2 = 1 | 16 |
| 16 | mod 2 = 0 | 0 |
| mod 2 = 1 | 1 |

<Unchanged parts are omitted>

#### 16.4.1.5 Modulation order and transport block size determination

To determine the modulation order in the NPDSCH, the UE shall

- if the UE is configured with higher layer parameter *npdsch-16QAM-Config* and the DCI is mapped onto the UE specific search space and the 4-bit "modulation and coding scheme" field () in the DCI is set to ‘1111’,

- use modulation order, **=** 4

- otherwise

- use modulation order, **=** 2.

To determine the transport block size in the NPDSCH, the UE shall first,

- if NPDSCH carriers SystemInformationBlockType1-NB

- set  to the value of the parameter schedulingInfoSIB1 configured by higher-layers

- else if NPDSCH with 16QAM

- read the 4-bit "modulation and coding scheme for 16QAM" () in the DCI

- If for the carrier on which NPSS/NSSS/NPBCH are detected the value of the higher layer parameter *operationModeInfo* is set to '00' or '01', or if the value of the higher layer parameter *inbandCarrierInfo-r13* is configured for a higher layer configured carrier if any, set , otherwise set

- otherwise

- read the 4-bit "modulation and coding scheme" field () in the DCI and set .

and second,

- if NPDSCH carriers SystemInformationBlockType1-NB

- use Clause 16.4.1.5.2 for determining its transport block size.

- otherwise,

- read the 3-bit "resource assignment" field () in the DCI and determine its TBS by the procedure in Clause 16.4.1.5.1.

For a NPDCCH UE-specific search space, if the UE is configured with higher layer parameter *twoHARQ-ProcessesConfig*, or the UE is configured with higher layer parameter *npdsch-MultiTB-Config* and single TB is scheduled in the corresponding DCI

- the NDI and HARQ process ID as signalled on NPDCCH, and the TBS, as determined above, shall be delivered to higher layers,

otherwise

- the NDI as signalled on NPDCCH, and the TBS, as determined above, shall be delivered to higher layers. If the UE is configured with higher layer parameter *npdsch-MultiTB-Config* and multiple TB are scheduled in the corresponding DCI, the HARQ process ID of 0 is for the first TB and HARQ process ID of 1 shall be assumed for the second TB, otherwise, HARQ process ID of 0 shall be assumed.

##### 16.4.1.5.1 Transport blocks not mapped for *SystemInformationBlockType1-NB*

The TBS is given by the (,) entry of Table 16.4.1.5.1-1.

If for the carrier on which NPSS/NSSS/NPBCH are detected the value of the higher layer parameter *operationModeInfo* is set to '00' or '01', or if the value of the higher layer parameter *inbandCarrierInfo-r13* is configured for a higher layer configured carrier if any,

- if NPDSCH with 16QAM , otherwise .

otherwise,

- if NPDSCH with 16QAM , otherwise

Table 16.4.1.5.1-1: Transport block size (TBS) table.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 0 | 16 | 32 | 56 | 88 | 120 | 152 | 208 | 256 |
| 1 | 24 | 56 | 88 | 144 | 176 | 208 | 256 | 344 |
| 2 | 32 | 72 | 144 | 176 | 208 | 256 | 328 | 424 |
| 3 | 40 | 104 | 176 | 208 | 256 | 328 | 440 | 568 |
| 4 | 56 | 120 | 208 | 256 | 328 | 408 | 552 | 680 |
| 5 | 72 | 144 | 224 | 328 | 424 | 504 | 680 | 872 |
| 6 | 88 | 176 | 256 | 392 | 504 | 600 | 808 | 1032 |
| 7 | 104 | 224 | 328 | 472 | 584 | 680 | 968 | 1224 |
| 8 | 120 | 256 | 392 | 536 | 680 | 808 | 1096 | 1352 |
| 9 | 136 | 296 | 456 | 616 | 776 | 936 | 1256 | 1544 |
| 10 | 144 | 328 | 504 | 680 | 872 | 1032 | 1384 | 1736 |
| 11 | 176 | 376 | 584 | 776 | 1000 | 1192 | 1608 | 2024 |
| 12 | 208 | 440 | 680 | 904 | 1128 | 1352 | 1800 | 2280 |
| 13 | 224 | 488 | 744 | 1032 | 1256 | 1544 | 2024 | 2536 |
| 14 | 256 | 552 | 840 | 1128 | 1416 | 1736 | 2280 | 2856 |
| 15 | 280 | 600 | 904 | 1224 | 1544 | 1800 | 2472 | 3112 |
| 16 | 296 | 632 | 968 | 1288 | 1608 | 1928 | 2600 | 3240 |
| 17 | 336 | 696 | 1064 | 1416 | 1800 | 2152 | 2856 | 3624 |
| 18 | 376 | 776 | 1160 | 1544 | 1992 | 2344 | 3112 | 4008 |
| 19 | 408 | 840 | 1288 | 1736 | 2152 | 2600 | 3496 | 4264 |
| 20 | 440 | 904 | 1384 | 1864 | 2344 | 2792 | 3752 | 4584 |
| 21 | 488 | 1000 | 1480 | 1992 | 2472 | 2984 | 4008 | 4968 |

<Unchanged parts are omitted>



<Unchanged parts are omitted>

#### 16.5.1.1 Resource allocation

The resource allocation information in uplink DCI format N0 for NPUSCH transmission or configured by higher layers for NPUSCH transmission using preconfigured uplink resource indicates to a scheduled UE

* a set of contiguously allocated subcarriers () of a resource unit determined by the Subcarrier indication field, or by the higher layer parameter *npusch-SubCarrierSetIndex* in *PUR-Config-NB*
* a number of resource units () determined by the resource assignment field according to Table 16.5.1.1-2, or by the higher layer parameter *npusch-NumRUsIndex* in *PUR-Config-NB*
* a repetition number () determined by the repetition number field according to Table 16.5.1.1-3. For a NPUSCH transmission using preconfigured uplink resource, the UE shall use the repetition number configured by higher layers. For NPUSCH with 16QAM, .

The subcarrier spacing  of NPUSCH transmission is determined by

- the higher layer parameter *npusch-SubCarrierSetIndex*, in the case of NPUSCH transmission using preconfigured uplink resources and subsequent NPUSCH transmissions until a Narrowband Random Access Response Grant is received,

- the uplink subcarrier spacing field in the Narrowband Random Access Response Grant according to Clause 16.3.3 otherwise.

For NPUSCH transmission with subcarrier spacing, where  is the subcarrier indication field and is reserved, or *n*sc is configured by higher layers parameter *npusch-SubCarrierSetIndex* in *PUR-Config-NB* for NPUSCH transmissions using preconfigured uplink resources.

For NPUSCH transmission with subcarrier spacing, the subcarrier indication field () in the DCI or *npusch-SubCarrierSetIndex* in *PUR-Config-NB* for NPUSCH transmissions using preconfigured uplink resources determines the set of contiguously allocated subcarriers () according to Table 16.5.1.1-1.

Table 16.5.1.1-1: Allocated subcarriers for NPUSCH with .

|  |  |
| --- | --- |
| Subcarrier indication field () | Set of Allocated subcarriers () |
| 0 – 11 |  |
| 12-15 |  |
| 16-17 |  |
| 18 |  |
| 19-63 | Reserved |

Table 16.5.1.1-2: Number of resource units () for NPUSCH.

|  |  |
| --- | --- |
|  |  |
| 0 | 1 |
| 1 | 2 |
| 2 | 3 |
| 3 | 4 |
| 4 | 5 |
| 5 | 6 |
| 6 | 8 |
| 7 | 10 |

Table 16.5.1.1-3: Number of repetitions () for NPUSCH.

|  |  |
| --- | --- |
|  |  |
| 0 | 1 |
| 1 | 2 |
| 2 | 4 |
| 3 | 8 |
| 4 | 16 |
| 5 | 32 |
| 6 | 64 |
| 7 | 128 |

#### 16.5.1.2 Modulation order, redundancy version and transport block size determination

To determine the modulation order, redundancy version and transport block size for the NPUSCH, the UE shall first

- read the "modulation and coding scheme" field () in the DCI or configured by higher layers for NPUSCH transmission using preconfigured uplink resource, and

- read the "redundancy version" field () in the DCI or initiate with for NPUSCH transmission using preconfigured uplink resource, and

- read the "resource assignment" field () in the DCI or configured by higher layers for NPUSCH transmission using preconfigured uplink resource, and

- compute the total number of allocated subcarriers (), number of resource units (), and repetition number () according to Clause 16.5.1.1.

If the UE is configured with higher layer parameter *edt-Parameters* and the most recent NPUSCH transmission including a transport block with EDT, the UE is not expected to receive a DCI indicating a NPUSCH retransmission as part of the contention based random access procedure with 3 ≤ *I*MCS ≤ 14.

If the UE is configured with higher layer parameter *edt-Parameters*, and for a NPUSCH retransmission of the same transport block including EDT as part of the contention based random access procedure with  in the DCI,

- the modulation order is set to ****.

- if the UE is configured with higher layer parameter *edt-SmallTBS-Enabled* set to 'true', the repetition number for the NPUSCH retransmission is the smallest integer multiple of  value that is equal to or larger than where  is the TBS corresponding to the NPUSCH transmission scheduled by the Narrowband Random Access Response Grant, and  is given by the higher layer parameter *edt-TBS*.

elseif the UE is configured with higher layer parameter *edt-Parameters*, and if the DCI indicates a retransmission as part of the contention based random access procedure with  and the most recent NPUSCH transmission including a transport block with EDT,

- the TBS and modulation are determined according to Table 16.3.3-1 in Clause 16.3.3, for  and the transport block does not include EDT

elseif the UE is configured with higher layer parameter *npusch-16QAM-Config*, and the DCI is mapped onto the UE specific search space and  set to ‘1111’, or for NPUSCH transmission using preconfigured uplink resource and higher layer parameter *pur-UL-16QAM-Config* configured, **=** 4

otherwise, the UE shall use modulation order, **=** 2 if . The UE shall useand Table 16.5.1.2-1 to determine the modulation order to use for NPUSCH if .

Table 16.5.1.2-1: Modulation and TBS index table for NPUSCH with .

|  |  |  |
| --- | --- | --- |
| MCS Index | Modulation Order | TBS Index |
| **0** | 1 | 0 |
| **1** | 1 | 2 |
| **2** | 2 | 1 |
| **3** | 2 | 3 |
| **4** | 2 | 4 |
| **5** | 2 | 5 |
| **6** | 2 | 6 |
| **7** | 2 | 7 |
| **8** | 2 | 8 |
| **9** | 2 | 9 |
| **10** | 2 | 10 |

If the UE is configured with higher layer parameter *npusch-MultiTB-Config* and multiple TB are scheduled in the corresponding DCI,  is used for each TB.

The NPUSCH associated with a TB is transmitted in *N* NB-IoT UL slots associated with the TB, *ni ,* *i=0,1,…,N-1*. For the NPUSCH transmission in *jt*h block of *B* consecutive NB-IoT UL slots associated with the TB *ni ,*, the redundancy version  associated with the TB is determined by, , where  if ,  otherwise. Portion of NPUSCH codeword with  associated with a TB as defined in clause 6.3.2 in [4] mapped to slot  of allocated  resource unit(s) is transmitted in NB-IoT UL slots associated with the TB *ni* for and  for 

The UE shall use (,) and Table 16.5.1.2-2 to determine the TBS to use for the NPUSCH. is given in Table 16.5.1.2-1 if , if NPUSCH with 16QAM except for NPUSCH transmission using preconfigured uplink resource,  otherwise. is the value of the "modulation and coding scheme for 16QAM" in the DCI.

Table 16.5.1.2-2: Transport block size (TBS) table for NPUSCH.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 0 | 16 | 32 | 56 | 88 | 120 | 152 | 208 | 256 |
| 1 | 24 | 56 | 88 | 144 | 176 | 208 | 256 | 344 |
| 2 | 32 | 72 | 144 | 176 | 208 | 256 | 328 | 424 |
| 3 | 40 | 104 | 176 | 208 | 256 | 328 | 440 | 568 |
| 4 | 56 | 120 | 208 | 256 | 328 | 408 | 552 | 680 |
| 5 | 72 | 144 | 224 | 328 | 424 | 504 | 680 | 872 |
| 6 | 88 | 176 | 256 | 392 | 504 | 600 | 808 | 1000 |
| 7 | 104 | 224 | 328 | 472 | 584 | 712 | 1000 | 1224 |
| 8 | 120 | 256 | 392 | 536 | 680 | 808 | 1096 | 1384 |
| 9 | 136 | 296 | 456 | 616 | 776 | 936 | 1256 | 1544 |
| 10 | 144 | 328 | 504 | 680 | 872 | 1000 | 1384 | 1736 |
| 11 | 176 | 376 | 584 | 776 | 1000 | 1192 | 1608 | 2024 |
| 12 | 208 | 440 | 680 | 1000 | 1128 | 1352 | 1800 | 2280 |
| 13 | 224 | 488 | 744 | 1032 | 1256 | 1544 | 2024 | 2536 |
| 14 | 256 | 552 | 840 | 1128 | 1416 | 1736 | 2280 |  |
| 15 | 280 | 600 | 904 | 1224 | 1544 | 1800 | 2472 |  |
| 16 | 328 | 632 | 968 | 1288 | 1608 | 1928 | 2536 |  |
| 17 | 336 | 696 | 1064 | 1416 | 1800 | 2152 |  |  |
| 18 | 376 | 776 | 1160 | 1544 | 1992 | 2344 |  |  |
| 19 | 408 | 840 | 1288 | 1736 | 2152 | 2536 |  |  |
| 20 | 440 | 904 | 1384 | 1864 | 2344 |  |  |  |
| 21 | 488 | 1000 | 1480 | 1992 | 2536 |  |  |  |

For a NPDCCH UE-specific search space, if the UE is configured with higher layer parameter *twoHARQ-ProcessesConfig*, or the UE is configured with higher layer parameter *npusch-MultiTB-Config* and single TB is scheduled in the corresponding DCI

- the NDI and HARQ process ID as signalled on NPDCCH, and the RV and TBS, as determined above, shall be delivered to higher layers,

otherwise

- the NDI as signalled on NPDCCH, and the RV and TBS, as determined above, shall be delivered to higher layers. If the UE is configured with higher layer parameter *npusch-MultiTB-Config* and multiple TB are scheduled in the corresponding DCI, HARQ process ID of 0 shall be assumed for the first TB and HARQ process ID of 1 shall be assumed for the second TB.

<Unchanged parts are omitted>