**3GPP TSG-RAN WG4 Meeting # 102-e R4-2204157 Electronic Meeting, February 21 – March 3, 2022**

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
|  |
|  | **38.101-1** | **CR** | **1002** | **rev** | **-** | **Current version:** | **17.4.0** |  |
|  |
| *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 |  | Core Network |  |

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|  |
| ***Title:***  | Big CR for TS38.101-1: Introduction of NR SL enhancements UE RF requirements in Rel-17 |
|  |  |
| ***Source to WG:*** | LG Electronics, Huawei, HiSilicon, CATT, AT&T |
| ***Source to TSG:*** | R4 |
|  |  |
| ***Work item code:*** | NR\_SL\_enh-Core |  | ***Date:*** | 2022-03-02 |
|  |  |  |  |  |
| ***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 canbe 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-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
|  |  |
| ***Reason for change:*** | This big CR is to introduce NR SL enhancement UE RF requirements in Rel-17. This CR provide to merge all the endorsed draft CRs for NR SL UE operation e.g. Public Safety service UE, PC2 V2X UE and intra-band con-current V2X operations. |
|  |  |
| ***Summary of change:*** | The following endorsed CRs are merged:1. R4-2206523, Draft big CR to merge the endorsed CRs for SL enhancement PS UE in Part1, LGE, endorsed in RAN4#102-e
	1. R4-2202408, Draft CR to add the PS UE RF requirements, LGE
	2. R4-2206522, Draft CR to add the FRC tables for 5MHz CBW, LGE
	3. R4-2206524, Draft CR to add PC2 TxD V2X UE RF requirements, Huawei
2. R4-2204174, Draft big CR for TS 38.101-1, RF requirements for intra-band con-current operation, CATT, endorsed in RAN4#102-e.
	1. R4-2202356, Draft CR TS 38.101-1: introduction on intra-band con-current V2X UE RF requirements in licensed band in Rel-17, LGE
	2. R4-2202358, draftCR for TS 38.101-1 on configured power for intra-band and inter-band concurrent operation, Xiaomi
	3. R4-2206529, Draft CR for TS 38.101-1, Remaining RF requirements for intra-band con-current operation, CATT
	4. [R4-2205136](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205136.zip), draft CR for TS 38.101-1 on default power class for intra-band concurrent operation, Xiaomi
	5. [R4-2206530](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205136.zip), Draft CR on MPR requirements for intra-band con-current V2X UE RF requirements in licensed band in Rel-17, LGE
 |
|  |  |
| ***Consequences if not approved:*** | The RF requirements for NRSL\_enh UE operation would be supported in specification. |
|  |  |
| ***Clauses affected:*** | 3.3, 4.3, 5.2E, 5.3E, 6.2E, 6.3E, 6.4E, 6.5E, 7.3E, 7.4E, 7.5E, 7.6E, 7.7E, 7.8E, A.7.2, A.7.3 and A.7.4 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** | **X** |  |  Test specifications | TS 38.521-3 |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* Start of Changes \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

ACLR Adjacent Channel Leakage Ratio

ACS Adjacent Channel Selectivity

A-MPR Additional Maximum Power Reduction

BS Base Station

BW Bandwidth

BWP Bandwidth Part

CA Carrier Aggregation

CA\_nX-nY Inter-band CA of component carrier(s) in one sub-block within Band nX and component carrier(s) in one sub-block within Band nY where nX and nY are the applicable NR *operating bands*

CC Component Carriers

CG Carrier Group

CP-OFDM Cyclic Prefix-OFDM

CW Continuous Wave

DC Dual Connectivity

DFT-s-OFDM Discrete Fourier Transform-spread-OFDM

DM-RS Demodulation Reference Signal

DTX Discontinuous Transmission

E-UTRA Evolved UTRA

EIRP Equivalent Isotropically Radiated Power

EVM Error Vector Magnitude

FR Frequency Range

FRC Fixed Reference Channel

FWA Fixed Wireless Access

GSCN Global Synchronization Channel Number

IBB In-band Blocking

IDFT Inverse Discrete Fourier Transformation

ITS Intelligent Transportation System

ITU‑R Radiocommunication Sector of the International Telecommunication Union

MBW Measurement bandwidth defined for the protected band

MCG Master Cell Group

MOP Maximum Output Power

MPR Allowed maximum power reduction

MSD Maximum Sensitivity Degradation

NR New Radio

NR-ARFCN NR Absolute Radio Frequency Channel Number

NS Network Signalling

OCNG OFDMA Channel Noise Generator

OOB Out-of-band

P-MPR Power Management Maximum Power Reduction

PRB Physical Resource Block

PS Public Safety

PSCCH Physical Sidelink Control CHannel

PSSCH Physical Sidelink Shared CHannel

QAM Quadrature Amplitude Modulation

RE Resource Element

REFSENS Reference Sensitivity

RF Radio Frequency

RMS Root Mean Square (value)

RSRP Reference Signal Receiving PowerRx Receiver

Rx Receiver

SC Single Carrier

SCG Secondary Cell Group

SCS Subcarrier spacing

SDL Supplementary Downlink

SEM Spectrum Emission Mask

SL Sidelink

SL-MIMO Sidelink-Multiple Antenna transmission

SNR Signal-to-Noise Ratio

SRS Sounding Reference Symbol

SS Synchronization Symbol

SUL Supplementary uplink

TAE Time Alignment Error

TAG Timing Advance Group

Tx Transmitter

TxD Tx Diversity

UL MIMO Uplink Multiple Antenna transmission

ULFPTx Uplink Full Power Transmission

V2X Vehicle to Everything

# 4 General

## 4.1 Relationship between minimum requirements and test requirements

The present document is a Single-RAT specification for NR UE, covering RF characteristics and minimum performance requirements. Conformance to the present specification is demonstrated by fulfilling the test requirements specified in the conformance specification 3GPP TS 38.521-1 [4].

The Minimum Requirements given in this specification make no allowance for measurement uncertainty. The test specification TS 38.521-1 [4] defines test tolerances. These test tolerances are individually calculated for each test. The test tolerances are used to relax the minimum requirements in this specification to create test requirements. For some requirements, including regulatory requirements, the test tolerance is set to zero.

The measurement results returned by the test system are compared - without any modification - against the test requirements as defined by the shared risk principle.

The shared risk principle is defined in Recommendation ITU‑R M.1545 [5].

## 4.2 Applicability of minimum requirements

a) In this specification the Minimum Requirements are specified as general requirements and additional requirements. Where the Requirement is specified as a general requirement, the requirement is mandated to be met in all scenarios

b) For specific scenarios for which an additional requirement is specified, in addition to meeting the general requirement, the UE is mandated to meet the additional requirements.

c) The spurious emissions power requirements are for the long-term average of the power. For the purpose of reducing measurement uncertainty it is acceptable to average the measured power over a period of time sufficient to reduce the uncertainty due to the statistical nature of the signal

d) All the requirements for intra-band contiguous and non-contiguous CA apply under the assumption of the same slot format indicated by UL-DL-configuration-common in the PCell and SCells for NR SA.

e) The requirements for Tx diversity in this release are applied for UE which indicates IE [*txDiversity-r16*].

## 4.3 Specification suffix information

Unless stated otherwise the following suffixes are used for indicating at 2nd level clause, shown in Table 4.3-1.

Table 4.3-1: Definition of suffixes

|  |  |
| --- | --- |
| Clause suffix | Variant |
| None | Single Carrier |
| A | Carrier Aggregation (CA) |
| B | Dual-Connectivity (DC) |
| C | Supplement Uplink (SUL) |
| D | UL MIMO |
| E | V2X |
| F | Shared spectrum channel access |
| G | Tx Diversity (TxD) |
| H | Carrier Aggregation(CA) for UL MIMO |

A terminal which supports the above features needs to meet both the general requirements and the additional requirement applicable to the additional clause (suffixes A to F) in clauses 5, 6 and 7. Where there is a difference in requirement between the general requirements and the additional clause requirements (suffixes A to F) in clauses 5, 6 and 7, the tighter requirements are applicable unless stated otherwise in the additional clause.

A terminal which supports more than one feature in clauses 5, 6 and 7 shall meet all of the separate corresponding requirements.

A terminal which supports advanced V2X services, public safety services and other commercial use cases related to NR sidelink operation shall meet all of the separate corresponding requirements in suffix E.

For a terminal that supports SUL for the band combination specified in Table 5.2C-1, the current version of the specification assumes the terminal is configured with active transmission either on UL carrier or SUL carrier at any time in one serving cell and the UE requirements for single carrier shall apply for the active UL or SUL carrier accordingly. For a terminal that supports SUL, the current version of the specification assumes the terminal is not configured with UL MIMO on SUL carrier.

For a terminal that supports public safety service using sidelink, the minimum requirements are applicable when

- The UE is associated with a serving cell on PS carrier, or

- The UE is not associated with a serving cell on the PS carrier and is provisioned with the preconfigured radio parameters for PS that are associated with known Geographical Area, or

- The UE is associated with a serving cell on a carrier different than the PS carrier, and the radio parameters for PS that are provided by the serving cell, or

- The UE is associated with a serving cell on a carrier different than the PS carrier, and has a non-serving cell selected on the PS carrier with the preconfigured radio parameters.

When the advanced-V2X or PS UE is not associated with a serving cell on the V2X or PS carrier, and the UE does not have knowledge of its geographical area, or is provisioned with preconfigured radio parameters that are not associated with any Geographical Area, V2X or PS UE’ transmissions are not allowed, and the requirements in Section 6.3E.2 apply.

For a terminal that supports operation in shared spectrum, the current version of this specification assumes in the uplink sub-bands within a wideband channel shall be contiguously allocated to the UE. The uplink requirements for one or more non-transmitted sub-bands between two transmitted sub-bands does not form a part of the current version of this specification.

*<Unchanged sections are omitted>*

## 5.2E Operating band for V2X

### 5.2E.1 V2X operating bands

NR V2X is designed to operate in the operating bands in FR1 defined in Table 5.2E.1-1.

Table 5.2E.1-1 V2X operating bands in FR1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| V2X Operating Band | Sidelink (SL) Transmission operating band | Sidelink (SL) Reception operating band | Duplex Mode | Interface |
|  | FUL\_low – FUL\_high | FDL\_low – FDL\_high |  |  |
| n142 | 788 MHz | - | 798 MHz | 788 MHz | - | 798 MHz | HD | PC5 |
| n381 | 2570 MHz | - | 2620 MHz | 2570 MHz | - | 2620 MHz | HD | PC5 |
| n47 | 5855 MHz | - | 5925 MHz | 5855 MHz | - | 5925 MHz | HD | PC5 |
| n79 | 4400 MHz | - | 5000 MHz | 4400 MHz | - | 5000 MHz | HD | PC5 |
| Note 1: When this band is used for V2X SL service, the band is exclusively used for NR V2X in particular regions.Note 2: When this band is used for public safety service, the NR band is operated with both in-coverage scenarios and out-of-coverage scenarios. |

### 5.2E.2 V2X operating bands for con-current operation

NR V2X operation is designed to operate concurrent with NR uplink/downlink on the operating bands combinations listed in Table 5.2E.2-1 and Table 5.2E.2-2.

Table 5.2E.2-1 Inter-band con-current V2X operating bands

|  |  |  |
| --- | --- | --- |
| V2X con-current operating Band | NR or V2X Operating Band | Interface |
| V2X\_n39-n47 | n39 | Uu |
|  | n47 | PC5 |
| V2X\_n40-n47 | n40 | Uu |
|  | n47 | PC5 |
| V2X\_n41-n47 | n41 | Uu |
|  | n47 | PC5 |
| V2X\_n71-n47 | n71 | Uu |
|  | n47 | PC5 |
| V2X\_n78-n47 | n78 | Uu |
|  | n47 | PC5 |
| V2X\_n79-n47 | n79 | Uu |
|  | n47 | PC5 |

Table 5.2E.2-2 Intra-band con-current V2X operating bands

|  |  |  |
| --- | --- | --- |
| V2X con-current operating Band | NR or V2X Operating Band | Interface |
| V2X\_n79-n79 | n79 | Uu |
|  | n79 | PC5 |

*<Unchanged sections are omitted>*

## 5.3E Channel bandwidth for V2X

### 5.3E.1 General

NR V2X operation channel bandwidths for each operating band is specified in Table 5.3.5-1 in clause 5.3.5. The same (symmetrical) channel bandwidth is specified for both the transmission and reception path. The maximum channel bandwidth for SL operation in licensed band is 40MHz

### 5.3E.2 Channel bandwidth for V2X concurrent operation

For NR V2X inter-band con-current operation in FR1, the NR V2X channel bandwidths for each operating band is specified in Table 5.3E.2-1.

Table 5.3E.2-1: Inter-band con-current V2X configurations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR V2X inter-band con-current operating configuration | NR Band | Interface | Channel bandwidth (MHz) (NOTE 1) | Bandwidth combination set |
|  |  | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |  |
| V2X\_n39A-n47A | n39 | Uu | 5 | 10 | 15 | 20 | 25 | 30 | 40 |  |  |  |  |  |  | 0 |
|  | n47 | PC5 |  | 10 |  | 20 |  | 30 | 40 |  |  |  |  |  |  |  |
| V2X\_n40A-n47A | n40 | Uu | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 |  | 80 |  |  | 0 |
|  | n47 | PC5 |  | 10 |  | 20 |  | 30 | 40 |  |  |  |  |  |  |  |
| V2X\_n41A-n47A | n41 | Uu | 5 | 10 | 15 | 20 |  | 30 | 40 | 50 | 60 |  | 80 | 90 | 100 | 0 |
|  | n47 | PC5 |  | 10 |  | 20 |  | 30 | 40 |  |  |  |  |  |  |  |
| V2X\_n71A-n47A | n71 | Uu | 5 | 10 | 15 | 20 |  |  |  |  |  |  |  |  |  | 0 |
|  | n47 | PC5 |  | 10 |  | 20 |  | 30 | 40 |  |  |  |  |  |  |  |
| V2X\_n78A-n47A | n78 | Uu |  | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 0 |
| n47 | PC5 |  | 10 |  | 20 |  | 30 | 40 |  |  |  |  |  |  |
| V2X\_n79A-n47A | n79 | Uu |  |  |  |  |  |  | 40 | 50 | 60 |  | 80 |  | 100 | 0 |
| n47 | PC5 |  | 10 |  | 20 |  | 30 | 40 |  |  |  |  |  |  |
| NOTE 1: The SCS of each channel bandwidth for NR band refers to Table 5.3.5-1. |

For NR V2X intra-band con-current operation in FR1, the NR V2X channel bandwidths for each operating band is specified in Table 5.3E.2-2.

Table 5.3E.2-2: Intra-band con-current V2X configurations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR V2X intra-band con-current operating configuration | NR Band | Interface | Channel bandwidth (MHz) (NOTE 1) | Bandwidth combination set |
|  |  | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |  |
| V2X\_n79B | n79 | Uu |  |  |  |  |  |  | 40 | 50 | 60 |  | 80 |  | 100 | 0 |
| n79 | PC5 |  | 10 |  | 20 |  | 30 | 40 |  |  |  |  |  |  |
| NOTE 1: The SCS of each channel bandwidth for NR band refers to Table 5.3.5-1. |

*<Unchanged sections are omitted>*

## 6.2E Transmitter power for V2X

### 6.2E.1 UE maximum output power for V2X

#### 6.2E.1.1 General

When NR V2X UE is configured for NR V2X sidelink transmissions non-concurrent with NR uplink transmissions for NR V2X operating bands specified in Table 5.2E.1-1, the allowed NR V2X UE maximum output power is specified in Table 6.2.1-1 in clause 6.2.1.

When a UE is configured for NR V2X sidelink transmissions in NR Band n47, the V2X UE shall meet the following additional requirements for transmission within the frequency ranges 5855-5925 MHz:

- The maximum mean power spectral density shall be restricted to 23 dBm/MHz EIRP when the network signaling value NS\_33 is indicated.

where the network signaling values are specified in clause 6.2E.3.

NOTE: The PSD limit in EIRP shall be converted to conducted requirement depend on the supported post antenna connector gain Gpost connector declared by the UE following the principle described in annex I in [11].

For NR V2X UE supporting SL MIMO or Tx diversity, the maximum output power requirements in Table 6.2E.1.1-1 is defined as the sum of the maximum output power from each UE antenna connector. The period of measurement shall be at least one sub frame (1 ms). For UE supporting SL MIMO, the requirements shall be met with the SL MIMO configurations specified in Table 6.2D.1-2.

Table 6.2E.1.1-1: NR V2X UE Power Class for SL-MIMO

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR band | Class 1 (dBm) | Tolerance (dB) | Class 2 (dBm) | Tolerance (dB) | Class 3 (dBm) | Tolerance (dB) | Class 4 (dBm) | Tolerance (dB) |
| n14 | 31 | +2/-3 |  |  | 23 | +2/-3 |  |  |
| n38 |  |  |  |  | 23 | +2/-3 |  |  |
| n47 |  |  | 26 | +2/-3 | 23 | +2/-3 |  |  |
| n79 |  |  |  |  | 23 | +2/-3 |  |  |

If the UE transmits on one antenna connector at a time, the requirements in Table 6.2.1-1 shall apply to the active antenna connector.

#### 6.2E.1.2 UE maximum output power for V2X con-current operation

For the inter-band con-current NR V2X operation, the maximum output power is specified in Table 6.2E.1.2-1. The period of measurement shall be at least one sub frame (1ms).

Table 6.2E.1.2-1: NR V2X UE Power Class for inter-band con-current combination (two bands)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR V2X con-current operating band Configuration | Class 1 (dBm)  | Tolerance (dB)  | Class 2 (dBm) | Tolerance(dB)  | Class 3 (dBm) | Tolerance (dB)  | Class 4 (dBm) | Tolerance (dB) |
| V2X\_n39A-n47A |  |  |  |  | 23 | +2/-32 |  |  |
| V2X\_n40A-n47A |  |  |  |  | 23 | +2/-32 |  |  |
| V2X\_n41A-n47A |  |  |  |  | 23 | +2/-32 |  |  |
| V2X\_n71A-n47A |  |  |  |  | 23 | +2/-34 |  |  |
| V2X\_n78A-n47A |  |  |  |  | 23 | +2/-32 |  |  |
| V2X\_n79A-n47A |  |  |  |  | 23 | +2/-32 |  |  |
| NOTE 1: The con-current band combinations are used for NR V2X Service.NOTE 2: PPowerClass is the maximum UE power specified without taking into account the tolerance NOTE 3: For inter-band con-current aggregation the maximum power requirement apply to the total transmitted power over all component carriers (per UE).NOTE 4: 4 refers to the transmission bandwidths (Figure 5.6-1) confined within FUL\_low and FUL\_low + 4 MHz or FUL\_high – 4 MHz and FUL\_high, the maximum output power requirement is relaxed by reducing the lower tolerance limit by 1.5 dB |

For the intra-band con-current NR V2X operation, the maximum output power is specified in Table 6.2E.1.2-2. The period of measurement shall be at least one sub frame (1ms).

Table 6.2E.1.2-2: NR V2X UE Power Class for intra-band con-current combination

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR V2X con-current operating band Configuration | Class 1 (dBm)  | Tolerance (dB)  | Class 2 (dBm) | Tolerance(dB)  | Class 3 (dBm) | Tolerance (dB)  | Class 4 (dBm) | Tolerance (dB) |
| V2X\_n79B |  |  | 26 | +2/-32 | 23 | +2/-32 |  |  |
| NOTE 1: The con-current band combinations are used for NR V2X Service.NOTE 2: PPowerClass is the maximum UE power specified without taking into account the tolerance NOTE 3: For intra-band con-current aggregation the maximum power requirement apply to the total transmitted power over all component carriers (per UE).NOTE 4: Power Class 3 is the default power class unless otherwise stated. |

*<Unchanged sections are omitted>*

### 6.2E.2 UE maximum output power reduction for V2X

#### 6.2E.2.1 General

When UE is configured for NR V2X sidelink transmissions non-concurrent with NR uplink transmissions for NR V2X operating bands specified in Table 5.2E.1-1, this clause specifies the allowed Maximum Power Reduction (MPR) power for V2X physical channels and signals due to PSCCH/PSSCH, PSFCH and S-SSB transmission.

#### 6.2E.2.2 MPR for Power class 2 and Power class 3 V2X UE

For contiguous allocation of PSCCH and PSSCH simultaneous transmission, the allowed MPR for the maximum output power for NR V2X physical channels PSCCH and PSSCH shall be as specified in Table 6.2E.2.2-1 for Power class 3 NR V2X UE and Table 6.2E.2.2-2 for power class 2 NR V2X UE.

Table 6.2E.2.2-1: Maximum Power Reduction (MPR) for power class 3 NR V2X

|  |  |
| --- | --- |
| Modulation | Channel bandwidth/MPR (dB) |
|  | Outer RB allocations | Inner RB allocations |
| CP-OFDM | QPSK | ≤ 4.5 | ≤ 2.5 |
|  | 16QAM | ≤ 4.5 | ≤ 2.5 |
|  | 64 QAM | ≤ 4.5 |
|  | 256 QAM | ≤ 7.0 |

Table 6.2E.2.2-2: Maximum Power Reduction (MPR) for power class 2 NR V2X

|  |  |
| --- | --- |
| Modulation | Channel bandwidth/MPR (dB) |
|  | Outer RB allocations | Inner RB allocations |
|  | QPSK | ≤ 5.5 | ≤ 2.5 |
| CP-OFDM | 16QAM |
|  | 64 QAM | ≤ 6 | ≤ 4.5 |
|  | 256 QAM | ≤ 7.0 |

For NR V2X UE supporting SL MIMO or Tx diversity, the allowed MPR for the maximum output power for NR V2X physical channels PSCCH and PSSCH are specified in Table 6.2E.2.2-3 for power class 2 UE.

Table 6.2E.2.2-3: Maximum Power Reduction (MPR) for power class 2 NR V2X with dual Tx

|  |  |
| --- | --- |
| **Modulation** | **Channel bandwidth/MPR (dB)** |
| **Outer RB allocations** | **Inner RB allocations** |
| CP-OFDM  | QPSK | [≤ 6.0] | [≤ 3.0] |
| 16QAM |
| 64 QAM | [≤ 7.0] | [≤ 5.5] |
| 256 QAM | [≤ 9.0] |

Where the following parameters are defined to specify valid RB allocation ranges for Outer and Inner RB allocations:

NRB is the maximum number of RBs for a given Channel bandwidth and sub-carrier spacing defined in Table 5.3.2-1.

RBStart,Low = max(1, floor(LCRB/2))

where max() indicates the largest value of all arguments and floor(x) is the greatest integer less than or equal to x.

RBStart,High = NRB – RBStart,Low – LCRB

The RB allocation is an Inner RB allocation if the following conditions are met

RBStart,Low ≤ RBStart ≤ RBStart,High,and

LCRB ≤ ceil(NRB/2)

where ceil(x) is the smallest integer greater than or equal to x.

The RB allocation is an Outer RB allocation for all other allocations which are not an Inner RB allocation.

For PSFCH with single RB transmission for PC3 NR V2X UE, the required MPR is defined as follow

MPR\_PSFCH = 3.5 dB

For contiguous and non-contiguous allocation for simultaneous PSFCH transmission for PC3 and PC2 NR V2X UE, the required MPR are specified as follow

MPR\_PSFCH = CEIL {MA\_PSFCH, 0.5}

Where MA\_PSFCH for power class 3 is defined as follows

MA\_PSFCH = 7.5 ; 0.00< NGap/NRB ≤ 0.55

= 12.0 ; 0.55< NGap/NRB ≤1.0

For PSFCH with single RB transmission for PC2 NR V2X UE, the required MPR is defined as follow

MPR\_PSFCH = [4.5] dB

For contiguous and non-contiguous allocation for simultaneous PSFCH transmission for PC2 NR V2X UE, the required MPR are specified as follow

MPR\_PSFCH = CEIL {MA\_PSFCH, 0.5}

Where MA is defined as follows

Where MA\_PSFCH for power class 2 is defined as follows

MA\_PSFCH = 8.5 ; 0.00 ≤ NGap/NRB < 0.4

= 10.0 ; 0.4 ≤ NGap/NRB < 0.55

= 14.0 ; 0.55 ≤ NGap/NRB ≤ 1.0

Where,

NGap is the gap RB amount between RBstart and RBend for contiguous and non-contiguous allocation simultaneous PSFCH transmission. (NGap = RBend - RBstart)

CEIL{MA, 0.5} means rounding upwards to closest 0.5dB.

The allowed MPR for the maximum output power for NR V2X physical channels on S-SSB transmission shall be specified in Table 6.2E.2.2-2 for power class 3 and power class 2.

Table 6.2E.2.2-2: Maximum Power Reduction (MPR) for S-SSB transmission for power class 3 and power class 2 NR V2X

|  |  |
| --- | --- |
| Channel | MPRS-SSB (dB) |
|  | Outer RB allocations | Inner RB allocations |
| S-SSB | ≤ 6.0 | ≤ 2.5 |

For NR V2X UE with two transmit antenna connectors, the allowed Maximum Power Reduction (MPR) values specified in clause 6.2E.2 for PC3 and PC2 shall apply to the maximum output power specified in Table 6.2E.1.1-1. For UE supporting SL MIMO, the requirements shall be met with SL MIMO configurations defined in Table 6.2D.1-2. For UE supporting SL MIMO or Tx diversity, the maximum output power is defined as the sum of the maximum output power from each UE antenna connector.

For the UE maximum output power modified by MPR, the power limits specified in clause 6.2E.4 apply.

#### 6.2E.2.3 MPR for Power class 2 and Power class 3 V2X con-current operation

For the inter-band con-current NR V2X operation, the allowed maximum power reduction (MPR) for the maximum output power shall be applied per each component carrier. The MPR requirements in clause 6.2.2 apply for NR Uu operation in licensed band, and the MPR requirements in in clause 6.2E.2 apply for NR sidelink operation in licensed band or Band n47.

For the intra-band con-current NR V2X operation with contiguous RB allocation, the allowed maximum power reduction (MPR) for NR V2X physical channels PSCCH and PSSCH shall be as specified in Table 6.2E.2.3-1 for Power class 3 V2X con-current UE.

Table 6.2E.2.3-1: MPR for contiguous RB allocation for power class 3 NR V2X con-current UE

|  |  |
| --- | --- |
| Higher Modulation order between Sidelink and Uplink | MPR for bandwidth class B(dB) |
| Inner RB allocation | Outer RB allocation |
| CP-OFDM | QPSK | ≤ [2.5] | ≤ [4.5] |
| 16QAM | ≤ [2.5] | ≤ [4.5] |
| 64QAM | ≤ [4.5] | ≤ [5.0] |
| 256QAM | ≤ [6.0] | ≤ [6.0] |

For bandwidth class B with contiguous RB allocation, the following parameters are defined to specify valid RB allocation ranges for Inner and Outer RB allocations:

An RB allocation is contiguous if LCRB1 = 0 or LCRB2 = 0 or (LCRB1 ≠ 0 and LCRB2 ≠ 0 and RBStart1 + LCRB1 = NRB1 andRBStart2 = 0), where RBStart1, LCRB1, and NRB1 are for SL CC1, RBStart2, LCRB2, and NRB2 are for UL CC2. SL CC1 is the component carrier with lower frequency.

In contiguous NR V2X intra-band con-current operation, a contiguous allocation is an inner allocation if

RBStart,Low ≤ RBStart\_SL&UL ≤ RBStart,High,and NRB\_alloc ≤ ceil(NRB,agg /2),

where

RBStart,Low = max(1, floor(NRB\_alloc /2))

RBStart,High = NRB,agg – RBStart,Low – NRB,alloc,

with

NRB\_alloc= LCRB1 ∙ 2µ1 + LCRB2 ∙ 2µ2

NRB\_alloc= (NRB1 - RBStart1)∙ 2µ1 + (RBStart2 + LCRB2 ) ∙ 2µ2,

NRB,agg=NRB1∙2µ1+ NRB2∙2µ2.

If LCRB1 =0, RBStart\_SL&UL = NRB1∙2µ1+ RBStart2∙2µ2,

if LCRB1 > 0, RBStart\_SL&UL = RBStart1∙2µ1.

Where, µ1 and µ2 is 0, 1 and 2 for SCS of 15kHz, 30kHz and 60kHz respectively.

A contiguous allocation that is not an Inner contiguous allocation is an Outer contiguous allocation.

For the intra-band con-current NR V2X operation with non-contiguous RB allocation, the allowed maximum power reduction (MPR) for NR V2X physical channels PSCCH and PSSCH shall be as specified in Table 6.2E.2.3-2 for Power class 3 V2X con-current UE.

Table 6.2E.2.3-2: MPR for non-contiguous RB allocation for power class 3 NR V2X con-current UE

|  |  |
| --- | --- |
| Higher Modulation order between Sidelink and Uplink | MPR for bandwidth class B(dB) |
| Inner RB allocation | Outer1 RB allocation | Outer2 RB allocation |
| CP-OFDM | QPSK | ≤ [2.5] | ≤ [4.0] | ≤ [4.5] |
| 16QAM | ≤ [2.5] | ≤ [4.0] | ≤ [4.5] |
| 64QAM | ≤ [4.5] | ≤ [4.5] | ≤ [5.0] |
| 256QAM | ≤ [6.0] | ≤ [6.0] | ≤ [6.0] |

For bandwidth classes B with non-contiguous RB allocation, the following parameters are defined to specify valid RB allocation ranges for Inner, Outer1 and Outer2 RB allocations:

Non-Contiguous RB allocation is defined as RBStart1 + LCRB1 < NRB1, orRBStart2 > 0, when both SL CC and UL CC are activated and allocated with RB(s), where RBStart1, LCRB1, and NRB1 are for SL CC1, RBStart2, LCRB2, and NRB2 are for UL CC2. SL CC1 is the component carrier with lower frequency.

In contiguous NR V2X intra-band con-current operation, a non-contiguous RB allocation is a non-contiguous Inner RB allocation if the following conditions are met:

RBStart,Low ≤ RBStart\_CA ≤ RBStart,High and NRB\_alloc ≤ ceil((BWChannel\_SL&UL / 3 – BWgap ) / 0.18MHz),

where

NRB\_alloc = (NRB1 - RBStart1)∙ 2µ1 + (RBStart2 + LCRB2 ) ∙ 2µ2, RBStart\_SL&UL = RBStart1∙2μ1

RBStart,Low = max(1, floor(NRB\_alloc + (BWgap – BWGB,low)/0.18MHz))

RBStart,High = floor((BWChannel\_SL&UL – 2 ∙ BWgap – BWGB,low)/0.18MHz – 2 ∙ NRB\_alloc)

BWGB,low =Foffset,low – (NRB1∙12+1)∙SCS1/2

BWgap is the bandwidth of the gap between NRB1 and NRB2 possible allocations of SL CC1 and UL CC2 respectively.

In contiguous NR V2X intra-band con-current operation, a non-contiguous RB allocation is a non-contiguous outer 1 RB allocation if the following conditions are met:

RBStart,Low ≤ RBStart\_SL&UL ≤ RBStart,High and NRB\_alloc ≤ ceil((3 BWChannel\_SL&UL / 5 – BWgap) / 0.18MHz)

where

RBStart,Low = max(1, 2 ∙ NRB\_alloc – floor( (BWChannel\_SL&UL – 2 ∙ BWgap + BWGB,low)/0.18MHz)),

RBStart,High = floor((2 ∙ BWChannel\_SL&UL – 3 ∙ BWgap – BWGB,low) / 0.18MHz – 3 ∙ NRB\_alloc)

NRB\_alloc , RBStart\_SL&UL , BWgap and BWGB,low are as defined for the Inner region.

In contiguous NR V2X intra-band con-current operation, a non-contiguous allocation is an Outer 2 allocation if it is neither a non-contiguous Inner allocation nor an Outer 1 allocation.

For PSFCH with single RB transmission for PC3 NR V2X intra-band con-current UE, the required MPR is specified in clause 6.2E.2.2 shall be applied.

For the allowed MPR for S-SSB transmission for PC3 NR V2X intra-band con-current UE, the required MPR is specified in clasue 6.2E.2.2 shall be applied.

For the intra-band con-current NR V2X operation with contiguous RB allocation in contiguous carrier, the allowed maximum power reduction (MPR) for NR V2X physical channels PSCCH and PSSCH shall be as specified in Table 6.2E.2.3-3 for Power class 2 V2X con-current UE.

Table 6.2E.2.3-3: MPR for contiguous RB allocation for power class 2 NR V2X con-current UE

|  |  |
| --- | --- |
| Higher Modulation order between Sidelink and Uplink | MPR for bandwidth class B(dB) |
| Inner RB allocation | Outer RB allocation |
| CP-OFDM | QPSK | ≤ [3.0] | ≤ [5.5] |
| 16QAM | ≤ [4.0] | ≤ [5.5] |
| 64QAM | ≤ [5.5] | ≤ [6.0] |
| 256QAM | ≤ [7.5] | ≤ [7.5] |

For the intra-band con-current NR V2X operation with non-contiguous RB allocation in contiguous carrier, the allowed maximum power reduction (MPR) for NR V2X physical channels PSCCH and PSSCH shall be as specified in Table 6.2E.2.3-4 for Power class 2 V2X con-current UE.

Table 6.2E.2.3-4: MPR for non-contiguous RB allocation for power class 2 NR V2X con-current UE

|  |  |
| --- | --- |
| Higher Modulation order between Sidelink and Uplink | MPR for bandwidth class B(dB) |
| Inner RB allocation | Outer1 RB allocation | Outer2 RB allocation |
| CP-OFDM | QPSK | ≤ [3.0] | ≤ [5.5] | ≤ [6.0] |
| 16QAM | ≤ [4.5] | ≤ [5.5] | ≤ [6.5] |
| 64QAM | ≤ [5.5] | ≤ [6.5] | ≤ [7.0] |
| 256QAM | ≤ [8.0] | ≤ [8.0] | ≤ [8.0] |

The parameters in clause 6.2E.2.3 are considered to determine MPR values according to RB allocation.

For PSFCH with single RB transmission for PC2 NR V2X intra-band con-current UE, the required MPR is specified in clause 6.2E.2.2 shall be applied.

For the allowed MPR for S-SSB transmission for PC2 NR V2X intra-band con-current UE, the required MPR is specified in clause 6.2E.2.2 shall be applied.

#### 6.2E.2.4 MPR for Power class 1 UE in n14

For NR Public Safety (PS) UE with contiguous allocation of PSCCH and PSSCH simultaneous transmission, the allowed NR PS UE maximum output power reduction for power class 1 UE shall be met the NR V2X MPR values specified in clause 6.2E.2.2.

*<Unchanged sections are omitted>*

### 6.2E.3 UE additional maximum output power reduction for V2X

#### 6.2E.3.1 General

For the applied maximum output power reduction is obtained by taking the maximum value of MPR requirements specified in clause 6.2E.2 and A-MPR requirements specified in clause 6.2E.3.

Additional emission requirements can be indicated by the network or pre-configured radio parameters. Each additional emission requirement is associated with a unique network signalling (NS) value indicated in RRC signalling by an NR frequency band number of the applicable operating band and an associated value in the field [*additionalSpectrumEmission*]*.* Throughout this specification, the notion of indication or signalling of an NS value refers to the corresponding indication of an NR V2X frequency band number of the applicable operating band, the IE field [*freqBandIndicatorNR*] and an associated value of [*additionalSpectrumEmission*]in the relevant RRC information elements [7]*.*

To meet the additional requirements, additional maximum power reduction (A-MPR) is allowed for the maximum output power as specified in Table 6.2.1-1. Outer and inner allocation notation used in clause 6.2E.3 is defined in clause 6.2E.2. In absence of modulation and waveform types the A-MPR applies to all modulation and waveform types.

Table 6.2E.3.1-1: Additional Maximum Power Reduction (A-MPR) for PC3 NR V2X

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Network Signalling value | Requirements (clause) | NR Band | Channel bandwidth (MHz) | Resources Blocks (*N*RB) | A-MPR (dB) |
| NS\_01 |  | Table 5.2E.1-1 | 10, 20, 30, 40 | Table 5.3.2-1 | N/A |
| NS\_06 | 6.5.2.3.4 (A-SEM) | n14 | 5, 10 | Table 5.3.2-1 | N/A |
| NS\_33 | 6.5E.2.3.1 (A-SEM)6.5E.3.4 (A-SE) | n47 | 10 | Clause 6.2E.3.2 |
| NS\_52 | 6.5E.2.3.2 (A-SEM) | n47 | 40 | Clause 6.2E.3.3 |

Table 6.2E.3.1-2: Mapping of network signaling label

|  |  |
| --- | --- |
| NR V2X operating bands | Value of additionalSpectrumEmission |
|  | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| n142 | NS\_01 | NS\_06 |  |  |  |  |  |  |
| n38 | NS\_01 |  |  |  |  |  |  |  |
| n47 | NS\_01 | NS\_33 | NS\_52 |  |  |  |  |  |
| NOTE 1: [*additionalSpectrumEmission*] corresponds to an information element of the same name defined in clause 6.3.2 of TS 38.331 [7].NOTE 2: For the NR PS UE in n14, same A-MPR shall be applied for PC1 PS UE since PC1 PS UE for Band n14 is not targeted for smartphone form factor. |

For UE with two transmit antenna connectors, the A-MPR values specified in clause 6.2.3 shall apply to the maximum output power specified in Table 6.2E.1-1. The requirements shall be met with the SL MIMO configurations specified in Table 6.2D.1-2. For UE supporting SL MIMO, the maximum output power is defined as the sum of the maximum output power from each UE antenna connector. Unless stated otherwise, an A-MPR of 0 dB shall be used.

For the UE maximum output power modified by A-MPR, the power limits specified in clause 6.2E.4 apply.

*<Unchanged sections are omitted>*

#### 6.2E.3.4 A-MPR for V2X con-current operation

For the inter-band con-current NR V2X operation, the allowed additional maximum power reduction (A-MPR) for the maximum output power shall be applied per each component carrier. The A-MPR requirements in clause 6.2.3 apply for NR Uu operation in licensed band, and the A-MPR requirements in in clause 6.2E.3 apply for NR sidelink operation in Band n47.

For the intra-band con-current NR V2X operation, the A-MPR requirements in [6.2E.3.4] apply for NR Uu and SL con-current operation in the licensed band.﻿

*<Unchanged sections are omitted>*

#### 6.2E.4.2 Configured transmitted power for inter-band V2X con-current operation

When a UE is configured for simultaneous NR V2X sidelink and NR uplink transmissions for inter-band con-current operation, the UE is allowed to set its configured maximum output power PCMAX,*c*,*NR*and PCMAX,*c*,*V2X*for the configured NR uplink carrier and the configured NR V2X carrier, respectively, and its total configured maximum output power PCMAX,c.

The configured maximum output power PCMAX *c*,*NR(p)* in slot *p* for the configured NR uplink carrier shall be set within the bounds:

PCMAX\_L,*c,NR* (*p*) ≤ PCMAX,*c,NR* (*p*) ≤ PCMAX\_H,*c,NR* (*p*)

where PCMAX\_L,*c,NR* andPCMAX\_H,*c,NR* are the limit as specified in clause 6.2E.4.1.

The configured maximum output power PCMAX *c*,*V2X (q)* in slot *q* for the configured NR V2X carrier shall be set within the bounds:

PCMAX,*c,V2X* (*q*) ≤ PCMAX\_H,*c,V2X* (*q*)

where PCMAX\_H,*c,V2X* is the limit as specified in clause 6.2E.4.

The total UE configured maximum output power PCMAX (*p,q*) in a slot *p* of NR uplink carrier and a slot *q* of NR V2X sidelink that overlap in time shall be set within the following bounds for synchronous and asynchronous operation unless stated otherwise:

PCMAX\_L (*p,q*) ≤ PCMAX (*p,q*) ≤ PCMAX\_H (*p,q*)

with

PCMAX\_L (*p,q*) = PCMAX\_L,*c,NR* (*p*)

PCMAX\_H (*p,q*) = 10 log10 [pCMAX\_H,*c,NR*(*p*) + pCMAX\_H,*c,V2X*(*q*)]

where pCMAX\_H*,c,V2X* and pCMAX\_H,*c,NR*are the limits PCMAX\_H,*c,V2X* (*q*) and PCMAX\_H,*c,NR* (*p*) expressed in linear scale.

The measured total maximum output power PUMAX over both the NR uplink and NR V2X carriers is

PUMAX = 10 log10 [pUMAX,*c,NR* + pUMAX,*c,V2X*],

where pUMAX,*c,NR*  denotes the measured output power of serving cell *c* for the configured NR uplink carrier, and pUMAX,*c,V2X* denotes the measured output power for the configured NR V2X carrier expressed in linear scale.

When a UE is configured for synchronous V2X sidelink and uplink transmissions,

PCMAX\_L(*p, q*)  – TLOW (PCMAX\_L(*p, q*)) ≤ PUMAX  ≤ PCMAX\_H(*p, q*) + THIGH (PCMAX\_H(*p, q*))

where PCMAX\_L (*p,q*) and PCMAX\_H (*p,q*) are the limits for the pair (*p,q*) and with the tolerances TLOW(PCMAX) and THIGH(PCMAX) for applicable values of PCMAX specified in Table 6.2E.4.1-1.. PCMAX\_L may be modified for any overlapping portion of slots *(p, q)* and *(p +1, q+1).*

#### 6.2E.4.3 Configured transmitted power for intra-band V2X con-current operation

For intra-band con-current operation, if transmission of Uu and SL does not overlap in time, the configured output power PCMAX,*c* specified in clause 6.2E.4.1 and 6.2.4 apply for SL and Uu transmission respectively; otherwise, if transmission of Uu and SL overlap in time, the configured maximum output power PCMAX,*c* on serving cell *c* for SL and Uu shall be set as specified in clause 6.2E.4.1 and in clause 6.2.4, but with MPR*c* = MPR and A-MPR*c* = A-MPR with MPR and A-MPR as determined by subclause 6.2E.2.3 for both PC3 and PC2 and subclause 6.2E.3.4, respectively. There is one power management term for the UE, denoted P-MPR, and P-MPR*c* = P-MPR.

The total configured maximum output power PCMAX shall be set within the following bounds:

 PCMAX\_L ≤ PCMAX ≤ PCMAX\_H

For intra-band concurrent operation when same slot pattern is used in all aggregated serving cells,

 PCMAX\_L  = MIN{10 log10 ∑ pEMAX,c  - TC , PPowerClass,con-current – MAX(MAX(MPR, A-MPR) + ΔTIB,c + TC, P-MPR) }

 PCMAX\_H  = MIN{10 log10 ∑ pEMAX,c , PPowerClass,co-ncurrent}

where

- pEMAX,c is the linear value of PEMAX,*c* which is given by IE *P-Max* for Uu serving cell *c* or by and[*sl-MaxTransPower*] for SL defined in [7];

- PPowerClass,con-current is the maximum UE power specified in Table [6.2E.1.2-2] without taking into account the tolerance;

- MPR and A-MPR are specified in clause 6.2E.2 and 6.2E.3, respectively;

- TIB,c is the additional tolerance for serving cell *c* as specified in clause [6.2E.4.3]

- P-MPR is the power management term for the UE;

- TC is the highest value TC,c among all serving cells *c*;

For intra-band concurrent operation, when at least one different numerology/slot pattern is used in aggregated cells, the UE is allowed to set its configured maximum output power PCMAX,c(i),i for serving cell c(i) of slot numerology type *i*, and its total configured maximum output power PCMAX.

The configured maximum output power PCMAX,c(i),i (p) in slot p of serving cell c(i) on slot numerology type *i* shall be set within the following bounds:

PCMAX\_L,f,c(i),i (p) ≤ PCMAX,f,c(i), i (p) ≤ PCMAX\_H,f,c(i),i (p)

where PCMAX\_L,f,c (i),i (p) and PCMAX\_H,f,c(i),i (p) are the limits for a serving cell c(i) of slot numerology type i as specified in clause 6.2.4.

The total UE configured maximum output power PCMAX (p,q) in a slot p of slot numerology or symbol pattern *i*, and a slot q of slot numerology or symbol pattern *j* that overlap in time shall be set within the following bounds unless stated otherwise:

PCMAX\_L(p,q) ≤ PCMAX (p,q) ≤ PCMAX\_H (p,q)

When slots p and q have different transmissions lengths and belong to different cells on same band for intra-band operation:

PCMAX\_L (p,q) = MIN {10 log10 [pCMAX\_L,f,c(i),Uu,i (p) + pCMAX\_L,f,c(i),V2X,j (q)], PPowerClass,con-current}

PCMAX\_H (p,q) = MIN {10 log10 [pCMAX\_ H,f,c(i), Uu,,i (p) + pCMAX\_ H,f,c(i),V2X,j (q)], PPowerClass,con-current}

where pCMAX\_L,f,c (i),Uu,i and pCMAX\_ H,f,c(i),Uu,i are the respective limits PCMAX\_L,f,c (i),Uu,i and PCMAX\_H,f,c(i),Uu,i expressed in linear scale.

TREF and Teval are specified in Table 6.2E.4.3-1 when same and different slot patterns are used in aggregated carriers. For each TREF, the PCMAX\_L is evaluated per Teval and given by the minimum value taken over the transmission(s) within the Teval; the minimum PCMAX\_L over the one or more Teval is then applied for the entire TREF. The lesser of PPowerClass,Concurrent and PEMAX,Concurrent shall not be exceeded by the UE during any period of time.

Table 6.2E.4.3-1: PCMAX evaluation window for different slot and channel durations

|  |  |  |
| --- | --- | --- |
| TREF | Teval | Teval with frequency hopping |
| TREF of largest slot duration over both UL and SL CCs | Physical channel length | Min(Tno\_hopping, Physical Channel Length) |

The measured maximum output power PUMAX over all serving cells with same slot pattern shall be within the following range:

 PCMAX\_L – MAX{TL, TLOW(PCMAX\_L) } ≤ PUMAX  ≤ PCMAX\_H + THIGH(PCMAX\_H)

 PUMAX = 10 log10 ∑ pUMAX,c

where pUMAX,c denotes the measured maximum output power for serving cell *c* expressed in linear scale. The tolerances TLOW(PCMAX) and THIGH(PCMAX) for applicable values of PCMAX are specified in Table 6.2E.4.3-2. The tolerance TL is the absolute value of the lower tolerance for applicable NRV2X concurrent operation configuration as specified in Table 6.2A.1.3-1-2 for inter-band NR V2X concurrent operation.

The measured maximum output power PUMAX over all serving cells, when at least one slot has a different transmission numerology or slot pattern, shall be within the following range:

 P'CMAX\_L– MAX{TL, TLOW (P'CMAX\_L)} ≤ P'UMAX  ≤ P'CMAX\_H + THIGH (P'CMAX\_H)

 P'UMAX = 10 log10 ∑ p'UMAX,c

where p'UMAX,c denotes the average measured maximum output power for serving cell *c* expressed in linear scale over TREF. The tolerances TLOW(P'CMAX) and THIGH(P'CMAX) for applicable values of P'CMAX are specified in Table 6.2E.4.3-2 for intra-band carrier aggregation. The tolerance TL is the absolute value of the lower tolerance for applicable NR V2X concurrent operation configuration as specified in Table 6.2E.1.2-1 for inter-band carrier aggregation.

where:

 P'CMAX\_L  = MIN{ MIN {10log10∑( pCMAX\_L,f,c(i),i), PPowerClass,concurrent} over all overlapping slots in TREF}

 P'CMAX\_H = MAX{ MIN{10 log10 ∑ pEMAX,c , PPowerClass,concurrent} over all overlapping slots in TREF}

Table 6.2E.4.3-2: PCMAX tolerance for SL intra-band con-current operation

|  |  |  |
| --- | --- | --- |
| PCMAX(dBm) | ToleranceTLOW(PCMAX)(dB) | ToleranceTHIGH(PCMAX)(dB) |
| 26 ≤ PCMAX < 23 | 3 | 2 |
| 21 ≤ PCMAX ≤ 23 | 2.0 |
| 20 ≤ PCMAX < 21 | 2.5 |
| 19 ≤ PCMAX < 20 | 3.5 |
| 18 ≤ PCMAX < 19 | 4.0 |
| 13 ≤ PCMAX < 18 | 5.0 |
| 8 ≤ PCMAX < 13 | 6.0 |
| -40 ≤ PCMAX < 8 | 7.0 |

A UE supporting sidelink operation can be configured by higher layers with one or more sidelink resource pools. A sidelink resource pool can be associated with either sidelink resource allocation mode 1 or sidelink resource allocation mode 2.

For sidelink resource allocation in either mode 1 or mode 2, if UE is in RRC\_CONNECTED state, and the preparation procedure time for transmission of sidelink physical channel is available before of PUSCH preparation procedure time, for transmission of Uu and SL not overlap in time, the configured output power PCMAX,*c* specified in clause 6.2E.4.1 and in clause 6.2.4 apply for SL and Uu transmission respectively, otherwise, the configured maximum output power PCMAX specified in this clause shall apply.

For sidelink resource allocation mode 2, if UE is in RRC\_IDLE state, sidelink transmission is based on pre-configured sidelink resource pool, the UE configured output power is determined by sidelink only, where the configured output power specified in clause 6.2E.4.1 apply.

For sidelink resource allocation mode 2, if UE is in RRC\_INACTIVE state, and Uu does not support SDT, the configured output power specified in clause 6.2E.4.1 apply, otherwise, the configured maximum output power PCMAX in this clause shall apply.

*<Unchanged sections are omitted>*

## 6.3E Output power dynamics for V2X

### 6.3E.1 Minimum output power for V2X

#### 6.3E.1.1 General

When UE is configured for NR V2X sidelink transmissions non-concurrent with NR uplink transmissions for NR V2X operating bands in Table 5.2E.1-1, the minimum output power is specified in Table 6.3E.1.1-1. The minimum output power is defined as the mean power in at least one sub-frame 1 ms.

Table 6.3E.1.1-1: Minimum output power

|  |  |  |
| --- | --- | --- |
| Channel bandwidth(MHz) | Minimum output power(dBm) | Measurement bandwidth(MHz) |
| 51 | -30 | 4.515 |
| 10 | -30 | 9.375 |
| 20 | -30 | 19.095 |
| 30 | -28.2 | 28.815 |
| 40 | -27 | 38.895 |
| Note 1: The CBW is only applicable to PS UE in n14. |

For NR V2X UE with two transmit antenna connectors, the minimum output power is defined as the sum of the mean power at each transmit connector in one sub-frame (1 ms). The minimum output power shall not exceed the values specified for single carrier.

If the UE transmits on one antenna connector at a time, the requirements specified for single carrier shall apply to the active antenna connector.

#### 6.3E.1.2 Minimum output power for V2X con-current operation

For the inter-band con-current NR V2X operation, the requirements specified in clause 6.3.1 shall apply for the uplink in licensed band and the requirements specified in clause 6.3E.1 shall apply for the sidelink in licensed band or Band n47.

For intra-band con-current NR V2X operation, the minimum output power is defined per carrier and the requirement for NR uplink is specified in clause 6.3.1 and the requirement for NR sidelink is specified in clause 6.3E.1, respectively.

### 6.3E.2 Transmit OFF power for V2X

#### 6.3E.2.1 General

When UE is configured for NR V2X sidelink transmissions non-concurrent with NR uplink transmissions for NR V2X operating bands in Table 5.2E.1-1, the requirements specified in clause 6.3.2 apply.

Table 6.3E.2.1-1: Transmit OFF power

|  |  |  |
| --- | --- | --- |
| Channel bandwidth(MHz) | Transmit OFF power(dBm) | Measurement bandwidth(MHz) |
| 51 | -50 | 4.515 |
| 10 | -50 | 9.375 |
| 20 | -50 | 19.095 |
| 30 | -50 | 28.815 |
| 40 | -50 | 38.895 |
| Note 1: The CBW is only applicable to PS UE in n14. |

For NR V2X UE supporting SL MIMO, the transmit OFF power at each transmit antenna connector shall not exceed the values specified in Table 6.3E.2.1-1 for single carrier. Transmit off power is defined as the mean power in at least one sub-frame 1 ms.

#### 6.3E.2.2 Transmit OFF power for V2X con-current operation

For the inter-band con-current NR V2X operation, the requirements specified in clause 6.3.2 shall apply for the uplink in licensed band and the requirements specified in clause 6.3E.2 shall apply for the sidelink in licensed band or Band n47.

For intra-band con-current NR V2X operation, the transmit OFF power requirement is defined per carrier and the requirement for NR uplink is specified in clause 6.3.2 and the requirement for NR sidelink is specified in clause 6.3E.2, respectively.

### 6.3E.3 Transmit ON/OFF time mask for V2X

#### 6.3E.3.1 General

For NR V2X UE, additional requirements on ON/OFF time masks for V2X physical channels and signals are specified in this clause.

#### 6.3E.3.2 General time mask

The General ON/OFF time mask defines the observation period between the Transmit OFF and ON power and between Transmit ON and OFF power for PSCCH, and PSSCH transmissions in a slot wherein the last symbol is punctured to create a guard period.



Figure 6.3E.3.2-1: General PSCCH/PSSCH time mask for NR V2X UE

#### 6.3E.3.3 S-SSB time mask

The S-PSS/S-SSS/PSBCH time mask for NR V2X UE defines the observation period between transmit OFF and ON S-PSS power and between transmit ON PSBCH and OFF power in a slot wherein the last symbol is punctured to create a guard period.



Figure 6.3E.3.3-1: S-SSB time mask for NR V2X UE

For NR V2X UE supporting SL MIMO, the ON/OFF time mask requirements apply at each transmit antenna connector.

For UE with two transmit antenna connectors, the general ON/OFF time mask requirements specified in subclause 6.3E.3 apply to each transmit antenna connector. The requirements shall be met with the SL MIMO configurations described in subclause 6.2D.1.

If the UE transmits on one antenna connector at a time, the general ON/OFF time mask requirements apply to the active antenna connector.

#### 6.3E.3.4 Transmit ON/OFF time mask for V2X con-current operation

For the inter-band con-current NR V2X operation, the requirements specified in clause 6.3.3 shall apply for the uplink in licensed band and the requirements specified in clause 6.3E.3 shall apply for the sidelink in licensed band or Band n47.

For intra-band V2X con-current operation band specified in subclause 5.2.E.2, the general output power ON/OFF time mask is defined per carrier during the ON power period and the transient periods. The ON/OFF time mask specified in clause 6.3.3.1 is applicable for NR uplink and the ON/OFF time mask in 6.3E.3.1 is applicable for NR sidelink. The OFF period as specified in clause 6.3.3.1 shall only be applicable for each component carrier when all the component carriers are OFF.

For the TDM operation in same carrier with same bandwidth, the switching time mask in Figure 6.3E.3.4-1 shall be applied.



**Figure 6.3E.3.4-1: Time mask for switching between Uu and SL for same carrier case with same bandwidth**

For intra-band V2X con-current operation band specified in subclause 5.3.E.2, the switching time mask in Figure 6.3E.3.4-2 shall apply for the different carrier case. The switching time shall be located on the RAT of low priority when NR Uu and NR SL have different priorities based on priority information specified in TS 38.321 and TS38.213. It is up to UE implementation when NR Uu and NR SL have the same priority based on priority information specified in TS 38.213.



**Figure 6.3E.3.4-2: Time mask for switching between Uu and SL for different carrier case**

In the real field, there is a timing advance difference, i.e. $N\_{TA}∙T\_{c}$ between NR Uu slot and NR SL slot due to different timing advance of NR Uu and NR SL. The switching time masks do not include timing advance difference but the timing advance difference should be considered with the switching time for same carrier case and different carrier case.

### 6.3E.4 Power control for V2X

#### 6.3E.4.1 General

When UE is configured for NR V2X sidelink transmissions non-concurrent with NR uplink transmissions for NR V2X operating bands in Table 5.2E.1-1, the following requirements are applied for NR V2X sidelink transmission.

For NR V2X UE supporting SL MIMO, the power control tolerance for single carrier shall apply to the sum of output power at each transmit antenna connector.

If the UE transmits on one antenna connector at a time, the requirements for single carrier shall apply to the active antenna connector.

#### 6.3E.4.2 Absolute power tolerance

The requirements in clause 6.3.4.2 shall apply for NR V2X transmission.

#### 6.3E.4.3 Power control for V2X con-current operation

For the inter-band con-current NR V2X operation, the requirements specified in clause 6.3.4 shall apply for the uplink in licensed band and the requirements specified in clause 6.3E.4 shall apply for the sidelink in licensed band or Band n47.

For the intra-band con-current NR V2X operation, the requirements specified in clause 6.3.4 shall apply for the uplink in licensed band and the requirements specified in clause 6.3E.4 shall apply for the sidelink in licensed band.

*<Unchanged sections are omitted>*

## 6.4E Transmit signal quality for V2X

### 6.4E.1 Frequency error for V2X

#### 6.4E.1.1 General

The UE modulated carrier frequency for NR V2X sidelink transmissions in Table 5.2E.1-1, shall be accurate to within ±0.1 PPM observed over a period of 1 ms compared to the absolute frequency in case of using GNSS synchronization source. The same requirements applied over a period of 1 ms compared to the carrier frequency received from the gNB or V2X synchronization reference UE in case of using the gNB or V2X synchronization reference UE sidelink synchronization signals.

For NR V2X UE supporting SL MIMO, the UE modulated carrier frequency at each transmit antenna connector shall be accurate to within ±0.1 PPM observed over a period of 0.5 ms in case of using GNSS synchronization source. The same requirements apply over a period of 0.5 ms compared to the relative frequency in case of using the NR gNode B or V2X synchronization reference UE sidelink synchronization signals.

If the UE transmits on one antenna connector at a time, the requirements for single carrier shall apply to the active antenna connector.

#### 6.4E.1.2 Frequency error for V2X con-current operation

For the inter-band con-current NR V2X operation, the requirements specified in clause 6.4.1 shall apply for the uplink in licensed band and the requirements specified in clause 6.4E.1 shall apply for the sidelink in licensed band or Band n47.

For the intra-band con-current NR V2X operation, the requirements specified in clause 6.4.1 shall apply for the uplink in licensed band and the requirements specified in clause 6.4E.1 shall apply for the sidelink in licensed band.

### 6.4E.2 Transmit modulation quality for V2X

#### 6.4E.2.1 General

The transmit modulation quality requirements in this clause apply to V2X sidelink transmissions.

For NR V2X UE supporting SL MIMO, the transmit modulation quality requirements for single carrier shall apply to each transmit antenna connector.

If V2X UE transmits on one antenna connector at a time, the requirements specified for single carrier apply to the active antenna connector.

#### 6.4E.2.2 Error Vector Magnitude for V2X

For V2X sidelink physical channels PSCCH and PSSCH, the Error Vector Magnitude requirements shall be as specified for PUSCH in Table 6.4.2.1-1 except pi/2-BPSK for NR V2X operating bands in Table 5.2E.1-1. When sidelink transmissions are shortened due to transmission gap of one symbol at the end of the slot, the EVM measurement interval is reduced by one symbol, accordingly.

#### 6.4E.2.3 Carrier leakage for V2X

Carrier leakage of NR V2X sidelink transmission, the requirements for NR PUSCH in Table 6.4.2.2-1 shall be applied.

#### 6.4E.2.4 In-band emissions for V2X

For V2X sidelink physical channels PSCCH, PSSCH and PSBCH, the In-band emissions requirements shall be as specified for PUSCH in subclause 6.4.2.3 for the corresponding modulation and transmission bandwidth. When V2X transmissions are shortened due to transmission gap of one symbol at the end of the subframe, the In-band emissions measurement interval is reduced by one symbol, accordingly.

#### 6.4E.2.5 EVM equalizer spectrum flatness for V2X

For V2X sidelink physical channels PSCCH, PSSCH and PSBCH, the EVM equalizer spectrum flatness requirements shall be as specified for PUSCH in clause 6.4.2.4 for the corresponding modulation and transmission bandwidth.

#### 6.4E.2.6 Transmit modulation quality for V2X con-current operation

For the inter-band con-current NR V2X operation, the requirements specified in clause 6.4.2 shall apply for the uplink in licensed band and the requirements specified in clause 6.4E.2 shall apply for the sidelink in licensed band or Band n47.

For the intra-band con-current NR V2X operation, the requirements specified in clause 6.4.2 shall apply for the uplink in licensed band and the requirements specified in clause 6.4E.2 shall apply for the sidelink in licensed band.

*<Unchanged sections are omitted>*

## 6.5E Output RF spectrum emissions for V2X

### 6.5E.1 Occupied bandwidth for V2X

#### 6.5E.1.1 General

When UE is configured for NR V2X sidelink transmissions non-concurrent with NR uplink transmissions for NR V2X operating bands specified in Table 5.2E.1-1, the requirements in clause 6.5.1 shall apply for NR V2X sidelink transmission.

For NR V2X UE with two transmit antenna connectors, the occupied bandwidth at each transmitter antenna shall be less than the channel bandwidth specified in Table 6.5.1-1. The requirements shall be met with SL MIMO configurations described in clause 6.2D.1.

If V2X UE transmits on one antenna connector at a time, the requirements specified for single carrier shall apply to the active antenna connector.

#### 6.5E.1.2 Occupied bandwidth for V2X con-current operation

For the inter-band con-current NR V2X operation, the requirements specified in clause 6.5.1 shall apply for the uplink in licensed band and the requirements specified in clause 6.5E.1 shall apply for the sidelink in licensed band or Band n47.

For the intra-band con-current NR V2X operation, the requirements specified in clause 6.5.1 shall apply for the uplink in licensed band and the requirements specified in clause 6.5E.1 shall apply for the sidelink in licensed band.

### 6.5E.2 Out of band emission for V2X

#### 6.5E.2.1 General

When UE is configured for NR V2X sidelink transmissions non-concurrent with NR uplink transmissions for NR V2X operating bands specified in Table 5.2E.1-1, the requirements in clause 6.5E.2 apply for NR V2X sidelink transmission.

For NR V2X UE with two transmit antenna connectors, the requirements specified for single carrier shall apply to each transmit antenna connector. The requirements shall be met with SL MIMO configurations described in clause 6.2D.1.

#### 6.5E.2.2 Spectrum emission mask

##### 6.5E.2.2.1 General

For NR V2X UE, the existing NR general spectrum emission mask in subclause 6.5.2.2 applies for all supporting NR V2X channel bandwidths. The spectrum emission mask of the UE applies to frequencies (ΔfOOB) starting from the ± edge of the assigned NR channel bandwidth. For frequencies greater than (ΔfOOB), the power of any UE emission shall not exceed the levels specified in Table 6.5.2.2-1 for the specified channel bandwidth for NR V2X operating bands in Table 5.2E.1-1.

##### 6.5E.2.2.2 Spectrum emission mask for V2X con-current operation

For the inter-band con-current NR V2X operation, the general/additional SEM requirements specified in clause 6.5.2 shall apply for the uplink in licensed band and the general/additional SEM requirements specified in clause 6.5E.2 shall apply for the sidelink in licensed band or Band n47.

For the intra-band con-current NR V2X operation with bandwidth classes B, the general SEM requirements specified in clause 6.5.2 shall apply for both the uplink and the sidelink transmission in licensed band. The power of any intra-band con-current V2X UE emission shall not exceed the levels specified in Table 6.5.2.2-1 for the specified channel bandwidth.

#### 6.5E.2.3 Additional Spectrum emission mask

##### 6.5E.2.3.1 Requirements for network signalling value "NS\_33"

The additional spectrum mask in Table 6.5E.2.2.1-1 applies for NR V2X UE within 5 855 MHz to 5 950 MHz according to ETSI EN 302 571. Additional spectrum emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

When "NS\_33" is indicated in the cell or pre-configured radio parameters, the power of any V2X UE emission shall not exceed the levels specified in Table 6.5E.2.2.1-1.

Table 6.5E.2.2.1-1: Additional spectrum mask requirements for 10MHz channel bandwidth

|  |
| --- |
| Spectrum emission limit (dBm EIRP)/ Channel bandwidth |
| ΔfOOB(MHz) | 10 MHz | Measurement bandwidth |
| ± 0-0.5 | [$-13-12\left(^{\left|∆fOOB\right|}/\_{MHz}\right)$] | 100 kHz |
| ± 0.5-5 | [$-19-\frac{16}{9}\left(^{\left|∆fOOB\right|}/\_{MHz}-0.5\right)$] | 100 kHz |
| ± 5-10 | [$-27-2\left(^{\left|∆fOOB\right|}/\_{MHz}-5.0\right)$] | 100 kHz |

NOTE 1: As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

NOTE 2: Additional SEM for NR V2X overrides any other requirements in frequency range 5855-5950MHz.

NOTE 3: The EIRP requirement is converted to conducted requirement depend on the supported post antenna connector gain Gpost connector declared by the UE following the principle described in annex I in [11].

##### 6.5E.2.3.2 Requirements for network signalling value "NS\_52"

The additional spectrum mask in Table 6.5E.2.3.2-1 applies for NR V2X UE within 5 765 MHz to 6 005 MHz according to FCC regulation. Additional spectrum emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

When "NS\_52" is indicated in the cell or pre-configured radio parameters, the power of any V2X UE emission shall not exceed the levels specified in Table 6.5E.2.3.2-1.

Table 6.5E.2.3.2-1: Additional spectrum mask requirements for 40MHz channel bandwidth (fc = 5885MHz)

|  |  |  |
| --- | --- | --- |
| ΔfOOB (MHz) | Emission Limit (dBm) | Measurement Bandwidth |
| ±0-2 | -32 | 100kHz |
| ±2-10 | -36 | 100kHz |
| ±10-20 | -38 | 100kHz |
| ±20-40 | -43 | 100kHz |
| ±40-100 | -50 | 100kHz |

##### 6.5E.2.3.3 Requirements for network signalling value "NS\_06"

The additional spectrum mask are signalled by the network to indicate that the public safety (PS) UE in NR band n14 shall meet an additional for a specific deployement scenarios.

When "NS\_06" is indicated by serving cell or pre-configured radio parameters, the power of any PS UE emission shall not exceed the levels specified in Table 6.5.2.3.4-1.

#### 6.5E.2.4 Adjacent channel leakage ratio

##### 6.5E.2.4.1 General

Adjacent Channel Leakage power Ratio (ACLR) is the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency.

For NR V2X UE, the existing ACLR requirement for NR uplink transmission in clause 6.5.2.4 are applied for NR V2X UE for NR V2X operating bands in 5.2E.1-1.

For NR V2X UE with two transmit antenna connectors, the requirements specified for single carrier shall apply to each transmit antenna connector. The requirements shall be met with SL MIMO configurations described in clause 6.2D.1.

If V2X UE transmits on one antenna connector at a time, the requirements specified for single carrier shall apply to the active antenna connector.

##### 6.5E.2.4.2 ACLR for V2X con-current operation

For the inter-band con-current NR V2X operation, the ACLR requirement specified in clause 6.5.2.4 shall apply for the uplink in licensed band and the ACLR requirement specified in clause 6.5E.2.4 shall apply for the sidelink in licensed band or Band n47.

For the intra-band con-current NR V2X operation with bandwidth classes B, the ACLR requirement specified in clause 6.5A.2.4.1 shall apply for the both uplink and sidelink transmission in licensed band.

*<Unchanged sections are omitted>*

#### 6.5E.3.3 Spurious emissions for UE co-existence for V2X con-current operation

For the inter-band con-current NR V2X operation, the UE-coexistence requirements in Table 6.5E.3.1.1-1 apply for the corresponding inter-band con-current operation with transmission assigned to both uplink in licensed band and sidelink in Band n47.

Table 6.5E.3.3.1-1: Requirements for inter-band con-current V2X operation

|  |  |
| --- | --- |
| V2X | Spurious emission |
| con-current operating band configuration | Protected band | Frequency range (MHz) | Maximum Level (dBm) | MBW (MHz) | NOTE |
| V2X\_n39A-n47A | E-UTRA Band 1, 8, 22, 26, 28, 34, 40, 41, 42, 44, 45NR Band n79 | FDL\_low | - | FDL\_high | -50 | 1 |  |
|  | NR Band n77, n78 | FDL\_low | - | FDL\_high | -50 | 1 | 1 |
|  | Frequency range | 5925 | - | 5950 | -30 | 1 | 3, 4 |
|  | Frequency range | 5815 | - | 5855 | -30 | 1 | 3 |
| V2X\_n40A-n47A | E-UTRA Band 1, 3, 5, 7, 8, 22, 26, 28, 34, 39, 42, 44, 45, 68, 72NR Band n77, n78 | FDL\_low | - | FDL\_high | -50 | 1 |  |
|  | NR Band n79 | FDL\_low | - | FDL\_high | -50 | 1 | 1 |
|  | Frequency range | 5925 | - | 5950 | -30 | 1 | 3, 4 |
|  | Frequency range | 5815 | - | 5855 | -30 | 1 | 3 |
|  | E-UTRA Band 1, 3, 5, 8, 26, 28, 34, 39, 42, 44, 45, 65, 73NR Band n77, n78 | FDL\_low  | - | FDL\_high | -50 | 1 |  |
|  | NR Band n79 | FDL\_low  | - | FDL\_high | -50 | 1 | 1 |
|  | Frequency range | 5925 | - | 5950 | -30 | 1 | 3, 4 |
|  | Frequency range | 5815 | - | 5855 | -30 | 1 | 3 |
| V2X\_n71A-n47A | E-UTRA Band 4, 5, 12, 13, 14, 17, 24, 26, 30, 48, 66, 85 | FDL\_low | - | FDL\_high | -50 | 1 |  |
|  | E-UTRA Band 2, 25, 41, 70 | FDL\_low | - | FDL\_high | -50 | 1 | 1 |
|  | E-UTRA Band 29 | FDL\_low | - | FDL\_high | -38 | 1 | 2 |
|  | NR Band n71 | FDL\_low | - | FDL\_high | -50 | 1 |  |
|  | Frequency range | 5925 | - | 5950 | -30 | 1 | 3, 4 |
|  | Frequency range | 5815 | - | 5855 | -30 | 1 | 3 |
| V2X\_n78A-n47A | E-UTRA Band 1, 3, 5, 7, 8, 26 28, 34, 39, 40, 41, 65 | FDL\_low | - | FDL\_high | -50 | 1 |  |
|  | Frequency range | 5925 | - | 5950 | -30 | 1 | 3, 4 |
|  | Frequency range | 5815 | - | 5855 | -30 | 1 | 3 |
| V2X\_n79A-n47A | E-UTRA Band 1, 3, 5, 8, 28, 34, 39, 40, 41, 42, 65 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| NOTE 1: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.6.3.1-2 are permitted for each assigned E-UTRA carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. In case the exceptions are allowed due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of (2MHz + N x LCRB x 180kHz), where N is 2, 3 or 4 for the 2nd, 3rd or 4th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.NOTE 2: These requirements also apply for the frequency ranges that are less than FOOB (MHz) in Table 6.6.3.1-1 and Table 6.6.3.1A-1 from the edge of the aggregated channel bandwidth.NOTE 3: Applicable when NS\_33 is configured by the pre-configured radio parameters for power class 3 V2X UE.NOTE 4: In the frequency range x-5950MHz, SE requirement of -30dBm/MHz should be applied; where x = max (5925, fc + 15), where fc is the channel centre frequency. |

For the intra-band con-current NR V2X operation, the UE-coexistence requirements in Table 6.5A.3.2.1-1 apply for the corresponding intra-band con-current operation for the both uplink and sidelink transmission in licensed band.

*<Unchanged sections are omitted>*

### 6.5E.4 Transmit intermodulation

#### 6.5E.4.1 General

When UE is configured for NR V2X sidelink transmissions non-concurrent with NR uplink transmissions for NR V2X operating bands specified in Table 5.2E.1-1, the requirements in clause 6.5.4 apply for NR V2X sidelink transmission.

For NR V2X UE with two transmit antenna connectors, the requirements specified for single carrier shall apply to each transmit antenna connector. The requirements shall be met with the SL MIMO configurations described in clause 6.2D.1.

#### 6.5E.4.2 Transmit intermodulation for V2X con-current operation

For the inter-band con-current NR V2X operation, the requirements specified in clause 6.5.4 shall apply for the uplink in licensed band and the requirements specified in clause 6.5E.4 shall apply for the sidelink in licensed band or Band n47.

For the intra-band con-current NR V2X operation, the requirements specified in clause 6.5A.4 shall apply for both uplink and sidelink in licensed band.

*<Unchanged sections are omitted>*

## 7.3E Reference sensitivity for V2X

### 7.3E.1 General

The reference sensitivity power level PREFSENS\_V2X is the minimum mean power applied to each one of the UE antenna port for V2X UE, at which the throughput shall meet or exceed the requirements for the specified reference measurement channel.

### 7.3E.2 Minimum requirements

When UE is configured for NR V2X reception non-concurrent with NR uplink transmissions for NR V2X operating bands specified in Table 5.2E.1-1, the throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.7.2 with parameters specified in Table 7.3E.2-1.

Table 7.3E.2-1: Reference sensitivity of NR V2X Bands (PC5)

|  |  |  |
| --- | --- | --- |
| NR V2XBand | SCSkHz | Channel bandwidth / PREFSENS\_V2X(dBm) |
| 5MHz4 | 10 MHz | 20 MHz | 30 MHz | 40 MHz | DuplexMode |
| n14 | 15 | -95.9 | -92.7 |  |  |  | HD |
| 30 |  | -93.0 |  |  |  |
| 60 |  |  |  |  |  |
| n38 | 15 |  | -96.5 | -93.2 | -91.4 | -90.1 | HD |
|  | 30 |  | -96.1 | -93.4 | -91.7 | -90.2 |
|  | 60 |  | -96.9 | -93.1 | -91.9 | -90.4 |
| n47 | 15 |  | -92.5 | -89.2 | -87.4 | -86.1 | HD |
|  | 30 |  | -92.1 | -89.4 | -87.7 | -86.2 |
|  | 60 |  | -92.9 | -89.1 | -87.9 | -86.4 |
| n79 | 15 |  | -95.5 | -92.2 | -90.4 | -89.1 | HD |
| 30 |  | -95.1 | -92.4 | -90.7 | -89.2 |
| 60 |  | -95.9 | -92.1 | -90.9 | -89.4 |
| NOTE 1: Reference measurement channel is defined in A.7.2.NOTE 2: The signal power is specified per antenna port.NOTE 3: Void.NOTE 4: The CBW is only applicable for PS UE in n14.NOTE 5: These REFSENS values do not consider the impact of the near/far effect |

Table 7.3E.2-2: Sidelink TX configuration for reference sensitivity of NR V2X Bands (PC5)

|  |  |
| --- | --- |
|  | NR Band / SCS / Channel bandwidth / Duplex mode |
| NR V2X Band | SCSkHz | 5 MHz3 | 10 MHz | 20 MHz | 30 MHz | 40 MHz | Duplex Mode |
| n14 | 15 | 20 | 20 |  |  |  | HD |
| 30 |  | 10 |  |  |  |
| 60 |  |  |  |  |  |
| n38 | 15 |  | 50 | 105 | 160 | 216 | HD |
|  | 30 |  | 24 | 50 | 75 | 105 |
|  | 60 |  | 102 | 24 | 36 | 50 |
| n47 | 15 |  | 50 | 105 | 160 | 216 | HD |
|  | 30 |  | 24 | 50 | 75 | 105 |
|  | 60 |  | 102 | 24 | 36 | 50 |
| n79 | 15 |  | 50 | 105 | 160 | 216 | HD |
| 30 |  | 24 | 50 | 75 | 105 |
| 60 |  | 10 | 24 | 36 | 50 |
| NOTE 1: The sidelink allocated RB (LCRB) size could be adjusted according to resource pool configuration in [7].NOTE 2: For the case, 11 RB is allowed for S-SSB Block.NOTE 3: The CBW is only applicable for PS UE in n14. |

### 7.3E.3 Reference sensitivity power level for V2X con-current operation

When UE is configured for NR V2X reception on V2X carrier con-current with NR uplink and downlink, NR V2X sidelink throughput for the carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.7.2 with parameters specified in Table 7.3E.2-1 and 7.3E.2-2. Also the NR downlink throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.3 with parameters specified in table 7.3.2-1, 7.3.2-2 and 7.3.2-3. The reference sensitivity is defined to be met with all downlink component carriers active. The REFSENS of Uu downlink and PC5 sidelink will be tested at the same time.

For the inter-band con-current NR V2X operation, and the UE also supports an NR downlink inter-band con-current configuration in Table 7.3E.3-2, the minimum requirement for reference sensitivity shall be increased by the amount given in ΔRIB,V2X in Table 7.3E.3-2 for the corresponding NR V2X inter-band combinations.

For the intra-band con-current NR V2X operation, the reference sensitivity power level shall be applied per carrier. The requirements in clause 7.3.2 shall be appled for NR downlink carrier and the requirements in clause 7.3E.2 shall be applied for NR sidelink carrier. NR V2X sidelink throughput for the carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.7.2. Also the NR downlink throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.3.2 in TS38.101-1.

*<Unchanged sections are omitted>*

## 7.4E Maximum input level for V2X

### 7.4E.1 General

Maximum input level is defined as the maximum mean power received at the UE antenna port, at which the specified relative throughput shall meet or exceed the minimum requirements for the specified reference measurement channel. When UE is configured for NR V2X reception non-concurrent with NR uplink transmissions for NR V2X operating bands specified in Table 5.2E.1-1, the throughput shall be ≥ 95 % of the maximum throughput of the reference measurement channels as specified in Annexes A.7.3 and A.7.4 with parameters specified in Table 7.4E.1-1.

Table 7.4E.1-1: Maximum input level of NR V2X

|  |  |  |
| --- | --- | --- |
| Rx Parameter | Units  | Channel bandwidth |
|  |  | 5 MHz3 | 10 MHz | 20 MHz | 30 MHz | 40 MHz |
| Power in Transmission Bandwidth Configuration | dBm | -251 | -251 | -251 | -231 | -221 |
|  |  | -272 | -272 | -272 | -252 | -242 |
| NOTE 1: Reference measurement channel is A.7.3 for 64 QAM.NOTE 2: Reference measurement channel is A.7.4 for 256 QAM.NOTE 3: The CBW is only applicable for PS UE in n14. |

### 7.4E.2 Maximum input level for V2X con-current operation

For the inter-band con-current NR V2X operation, the requirements specified in clause 7.4E shall apply for the NR sidelink reception in the operating Bands in Table 5.2E.1-1 and the requirements specified in clause 7.4 shall apply for the NR downlink reception in licensed band while all downlink carriers are active.

For the intar-band con-current NR V2X operation, the requirements specified in clause 7.4A shall be applied which is defined as the maximum mean power received at the UE antenna port, over the transmission bandwidth configuration of each CC.

*<Unchanged sections are omitted>*

## 7.5E Adjacent channel selectivity for V2X

### 7.5E.1 General

Adjacent channel selectivity (ACS) is a measure of a receiver's ability to receive an NR signal at its assigned channel frequency in the presence of an adjacent channel signal at a given frequency offset from the centre frequency of the assigned channel. ACS is the ratio of the receive filter attenuation on the assigned channel frequency to the receive filter attenuation on the adjacent channel(s).

The UE shall fulfil the minimum requirements specified in Table 7.5E.1-1 for NR V2X UE. These requirements apply for all values of an adjacent channel interferer up to -25 dBm and for any SCS specified for the channel bandwidth of the wanted signal. However, it is not possible to directly measure the ACS; instead the lower and upper range of test parameters are chosen as in Table 7.5E.1-2 and Table 7.5E.1-3 for verification of the requirements specified in Table 7.5E.1-1. For these test parameters, when UE is configured for NR V2X reception non-concurrent with NR uplink transmissions for NR V2X operating bands specified in Table 5.2E.1-1, the throughput shall be ≥ 95 % of the maximum throughput of the reference measurement channels as specified in Annexes A.7.2.

In licensed band, the minimum requirements shall reuse the same ACS values with NR UE.

Table 7.5E.1-1: Adjacent channel selectivity for NR V2X

|  |  |  |
| --- | --- | --- |
| RX parameter | Units | Channel bandwidth |
|  |  | 5 MHz1 | 10 MHz | 20 MHz | 30 MHz | 40 MHz |
| ACS | dB | 33.0 | 33.0 | 27.0 | 25.5 | 24.0 |
| NOTE 1: The CBW is only applicable for PS UE in n14. |

Table 7.5E.1-2: Test parameters for Adjacent channel selectivity for V2X, Case 1

|  |  |  |
| --- | --- | --- |
| RX parameter | Units | Channel bandwidth |
|  |  | 10 MHz | 20 MHz | 30 MHz | 40 MHz |
| Power in transmission bandwidth configuration | dBm | PREFSENS\_V2X + 14 dB |
| Pinterferer | dBm | PREFSENS\_V2X + 45.5 dB | PREFSENS\_V2X + 39.5 dB | PREFSENS\_V2X + 38.0 dB | PREFSENS\_V2X + 36.5 dB |
| BWinterferer | MHz | 10 | 10 | 10 | 10 |
| Finterferer (offset) | MHz | 10 / -10 | 15 / -15 | 20 / -20 | 25 / -25 |
| NOTE 1: The interferer is QPSK modulated PUSCH containing data and reference symbols. Normal cyclic prefix is used.NOTE 2: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with 15 kHz SCS. |

Table 7.5E.1-2a: Test parameters for Adjacent channel selectivity in n14, Case 1

|  |  |  |
| --- | --- | --- |
| RX parameter | Units | Channel bandwidth |
|  |  | 5 MHz | 10 MHz | 20 MHz | 30 MHz | 40 MHz |
| Power in transmission bandwidth configuration | dBm | PREFSENS\_V2X + 14 dB |
| Pinterferer | dBm | PREFSENS\_V2X + 45.5 dB | PREFSENS\_V2X + 45.5 dB |  |  |  |
| BWinterferer | MHz | 5 | 5 |  |  |  |
| Finterferer (offset) | MHz | 5 / -5 | 7.5 / -7.5 |  |  |  |
| NOTE 1: The interferer is QPSK modulated PUSCH containing data and reference symbols. Normal cyclic prefix is used.NOTE 2: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with 15 kHz SCS. |

Table 7.5E.1-3: Test parameters for Adjacent channel selectivity for V2X, Case 2

|  |  |  |
| --- | --- | --- |
| RX parameter | Units | Channel bandwidth |
|  |  | 10 MHz | 20 MHz | 30 MHz | 40 MHz |
| Power in transmission bandwidth configuration | dBm | -56.5 | -50.5 | -49.0 | -47.5 |
| Pinterferer | dBm | -25 |
| BWinterferer | MHz | 10 | 10 | 10 | 10 |
| Finterferer (offset) | MHz | 10 / -10 | 15 / -15 | 20 / -20 | 25 / -25 |
| NOTE 1: The interferer is QPSK modulated PUSCH containing data and reference symbols. Normal cyclic prefix is used.NOTE 2: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with 15 kHz SCS. |

Table 7.5E.1-3a: Test parameters for Adjacent channel selectivity in n14, Case 2

|  |  |  |
| --- | --- | --- |
| RX parameter | Units | Channel bandwidth |
|  |  | 5 MHz | 10 MHz | 20 MHz | 30 MHz | 40 MHz |
| Power in transmission bandwidth configuration | dBm | -56.5 | -56.5 |  |  |  |
| Pinterferer | dBm | -25 |
| BWinterferer | MHz | 5 | 5 |  |  |  |
| Finterferer (offset) | MHz | 5/ -5 | 7.5 / -7.5 |  |  |  |
| NOTE 1: The interferer is QPSK modulated PUSCH containing data and reference symbols. Normal cyclic prefix is used.NOTE 2: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with 15 kHz SCS. |

### 7.5E.2 Adjacent channel selectivity for V2X con-current operation

For the inter-band con-current NR V2X operation, the requirements specified in clause 7.5E shall apply for the NR sidelink reception in the operating Bands in Table 5.2E.1-1 and the requirements specified in clause 7.5 shall apply for the NR downlink reception in licensed band while all downlink carriers are active.

For the intra-band con-current NR V2X operation, the SL carrier is configured with nominal channel spacing to the NR downlink carrier. The minimum requirement specified in clause 7.5A.1 shall be applied to the corresponding intra-band con-current V2X UE.

*<Unchanged sections are omitted>*

## 7.6E Blocking characteristics for V2X

### 7.6E.1 General

The blocking characteristic is a measure of the receiver's ability to receive a wanted signal at its assigned channel frequency in the presence of an unwanted interferer on frequencies other than those of the spurious response or the adjacent channels, without this unwanted input signal causing a degradation of the performance of the receiver beyond a specified limit. The blocking performance shall apply at all frequencies except those at which a spurious response occurs.

### 7.6E.2 In-band blocking

#### 7.6E.2.1 General

When UE is configured for NR V2X reception non-concurrent with NR uplink transmissions for NR V2X operating bands specified in Table 5.2E.1-1, the throughput of the wanted signal shall be ≥ 95 % of the maximum throughput of the reference measurement channels as specified in Annex A.7.2 with parameters specified in Table 7.6E.2.1-1 and Table 7.6E.2.1-2. The relative throughput requirement shall be met for any SCS specified for the channel bandwidth of the wanted signal.

Table 7.6E.2.1-1: In-band blocking parameters for NR V2X

|  |  |  |
| --- | --- | --- |
| RX parameter | Units | Channel bandwidth |
|  |  | 10 MHz | 20 MHz | 30 MHz | 40 MHz |
| Power in transmission bandwidth configuration | dBm | PREFSENS\_V2X + channel bandwidth specific value below |
|  | dB | 6 | 9 | 11 | 12 |
| BWinterferer | MHz | 10 |
| FIoffset, case 1 | MHz | 15 |
| FIoffset, case 2 | MHz | 25 |
| NOTE 1: The interferer is QPSK modulated PUSCH containing data and reference symbols. Normal cyclic prefix is used. |

Table 7.6E.2.1-1a: In-band blocking parameters in n14

|  |  |  |
| --- | --- | --- |
| RX parameter | Units | Channel bandwidth |
|  |  | 5 MHz | 10 MHz | 20 MHz | 30 MHz | 40 MHz |
| Power in transmission bandwidth configuration | dBm | PREFSENS\_V2X + channel bandwidth specific value below |
|  | dB | 6 | 6 |  |  |  |
| BWinterferer | MHz | 5 |
| FIoffset, case 1 | MHz | 7.5 |
| FIoffset, case 2 | MHz | 12.5 |
| NOTE 1: The interferer is QPSK modulated PUSCH containing data and reference symbols. Normal cyclic prefix is used. |

Table 7.6E.2.1-2: In-band blocking for NR V2X

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR band | Parameter | Unit | Case 1 | Case 2 |
| n14 | PInterferer | dBm | -56 | -44 |
| FInterferer (offset) | MHz | -BW/2 – FIoffset,case 1&BW/2 + FIoffset,case 1 | ≤-BW/2 – FIoffset,case 2&≥BW/2 + FIoffset,case 2 |
| FInterferer | MHz | NOTE 2 | FDL\_low – 15toFDL\_high + 15 |
| n38, n47 | Pinterferer | dBm | -44 | -44 |
|  | Finterferer (offset) | MHz | -BW/2 – FIoffset, case 1andBW/2 + FIoffset, case 1 | ≤ -BW/2 – FIoffset, case 2and≥ BW/2 + FIoffset, case 2 |
|  | Finterferer | MHz | NOTE 2 | FDL\_low – 30toFDL\_high + 30 |
| NOTE 1: For certain bands, the unwanted modulated interfering signal may not fall inside the UE receive band, but within the first 15 MHz below or above the UE receive band.NOTE 2: For each carrier frequency the requirement is valid for two frequencies:a. the carrier frequency -BW/2 – FIoffset, case 1 andb. the carrier frequency +BW/2 + FIoffset, case 1NOTE 3: FInterferer range values for unwanted modulated interfering signal are interferer center frequencies NOTE 4: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with 15 kHz SCS. |

#### 7.6E.2.2 In-band blocking for V2X con-current operation

For the inter-band con-current NR V2X operation, the requirements specified in clause 7.6E2 shall apply for the NR sidelink reception in the operating Bands in Table 5.2E.1-1 and the requirements specified in clause 7.6.2 shall apply for the NR downlink reception in licensed band while all downlink carriers are active.

For the intra-band con-current NR V2X operation, the SL carrier is configured with nominal channel spacing to the NR downlink carrier. The minimum requirement specified in clause 7.6A.2.1 shall be applied to the corresponding intra-band con-current V2X UE.

### 7.6E.3 Out-of-band blocking

#### 7.6E.3.1 General

For NR V2X bands out-of-band band blocking is defined for an unwanted CW interfering signal falling outside a frequency range 30 MHz below or above the UE receive band. When UE is configured for NR V2X reception non-concurrent with NR uplink transmissions for NR V2X operating bands specified in Table 5.2E.1-1, the throughput of the wanted signal shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.7.2 with parameters specified in Table 7.6E.3.1-1 and Table 7.6E.3.1-2. The relative throughput requirement shall be met for any SCS specified for the channel bandwidth of the wanted signal.

Table 7.6E.3.1-1: Out-of-band blocking parameters for NR V2X

|  |  |  |
| --- | --- | --- |
| RX parameter | Units | Channel bandwidth |
|  |  | 5 MHz2 | 10 MHz | 20 MHz | 30 MHz | 40 MHz |
| Power in transmission bandwidth configuration | dBm | PREFSENS\_V2X + channel bandwidth specific value below |
|  | dB | 6 | 6 | 9 | 11 | 12 |
| NOTE 1: Reference measurement channel is A.7.2.NOTE 2: The CBW is only applicable for PS UE in n14. |

Table 7.6E.3.1-2: Out of-band blocking for NR V2X

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NR band | Parameter | Units | Range 1 | Range 2 | Range 3 |
| n14 | Pinterferer | dBm | -44 | -30 | -15 |
| Finterferer (CW) | MHz | -60 < f – FDL\_low < -15or15 < f – FDL\_high < 60 | -85 < f – FDL\_low ≤ -60or60 ≤ f – FDL\_high < 85 | 1 ≤ f ≤ FDL\_low – 85orFDL\_high + 85 ≤ f≤ 12750 |
| n47 | Pinterferer | dBm | -44 | -30 | -15 |
|  | Finterferer (CW) | MHz | FDL\_low -30 toFDL\_low -60 | FDL\_low -60 toFDL\_low -85 | FDL\_low -85 to1 MHz |
|  |  |  | FDL\_high +30 toFDL\_high + 60 | FDL\_high +60 toFDL\_high +85 | FDL\_high +85 to+12750 MHz |
| n38 | Pinterferer | dBm | -44 | -30 | -15 |
|  | Finterferer (CW) | MHz | FDL\_low -30 toFDL\_low -60 | FDL\_low -60 toFDL\_low -85 | FDL\_low -85 to1 MHz |
| NOTE 1: The power level of the interferer (PInterferer) for Range 3 shall be modified to -20 dBm for FInterferer > 4400 MHz. |

#### 7.6E.3.2 Out-of-band blocking for V2X con-current operation

For the inter-band con-current NR V2X operation, the requirements specified in clause 7.6E3 shall apply for the NR sidelink reception in Band n47 and the requirements specified in clause 7.6.3 shall apply for the NR downlink reception in licensed band while all downlink carriers are active.

For the intra-band con-current NR V2X operation, the SL carrier is configured with nominal channel spacing to the NR downlink carrier. The minimum requirement specified in clause 7.6A.3.1 shall be applied to the corresponding intra-band con-current V2X UE.

*<Unchanged sections are omitted>*

## 7.7E Spurious response for V2X

### 7.7.E.1 General

Spurious response is a measure of the receiver’s ability to receive a wanted signal on its assigned channel frequency without exceeding a given degradation due to the presence of an unwanted CW interfering signal at any other frequency for which a response is obtained, i.e. for which the out-of-band blocking limit as specified in clause 7.6E.3 is not met.

When UE is configured for NR V2X reception non-concurrent with NR uplink transmissions for NR V2X operating bands specified in Table 5.2E.1-1, the throughput shall be ≥ 95 % of the maximum throughput of the reference measurement channels as specified in Annexes A.7.2 with parameters for the wanted signal as specified in Table 7.7E.1-1 and Table 7.7E.1-2 for NR V2X bands. The relative throughput requirement shall be met for any SCS specified for the channel bandwidth of the wanted signal.

Table 7.7E.1-1: Spurious response parameters for NR V2X

|  |  |  |
| --- | --- | --- |
| RX parameter | Units | Channel bandwidth |
|  |  | 5 MHz2 | 10 MHz | 20 MHz | 30 MHz | 40 MHz |
| Power in transmission bandwidth configuration | dBm | PREFSENS\_V2X + channel bandwidth specific value below |
|  | dB | 6 | 6 | 9 | 11 | 12 |
| NOTE 1: Reference measurement channel is A.7.2NOTE 2: The CBW is only applicable for PS UE in n14. |

Table 7.7E.1-2: Spurious response for NR V2X

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Level |
| PInterferer (CW) | dBm | -44 |
| FInterferer | MHz | Spurious response frequencies |

### 7.7E.2 Spurious response for V2X con-current operation

For the inter-band con-current NR V2X operation, the requirements specified in clause 7.7E shall apply for the NR sidelink reception in the operating Bands in Table 5.2E.1-1 and the requirements specified in clause 7.7 shall apply for the NR downlink reception in licensed band while all downlink carriers are active.

For the intra-band con-current NR V2X operation, the SL carrier is configured with nominal channel spacing to the NR downlink carrier. The minimum requirement specified in clause 7.7A.1 shall be applied to the corresponding intra-band con-current V2X UE.

*<Unchanged sections are omitted>*

## 7.8E Intermodulation characteristics for V2X

### 7.8E.1 General

Intermodulation response rejection is a measure of the capability of the receiver to receive a wanted signal on its assigned channel frequency in the presence of two or more interfering signals which have a specific frequency relationship to the wanted signal.

### 7.8E.2 Wide band Intermodulation

The wide band intermodulation requirement is defined using modulated NR carrier and a CW signal as interferer 1 and interferer 2 respectively. When UE is configured for NR V2X reception non-concurrent with NR uplink transmissions for NR V2X operating bands specified in Table 5.2E.1-1, the throughput shall be ≥ 95 % of the maximum throughput of the reference measurement channels as specified in Annexes A.7.2 with parameters specified in Table 7.8E.2-1 for NR V2X bands. The relative throughput requirement shall be met for any SCS specified for the channel bandwidth of the wanted signal.

Table 7.8E.2-1: Wide band intermodulation parameters for NR V2X

|  |  |  |  |
| --- | --- | --- | --- |
| NR band | Rx parameter | Units | Channel bandwidth |
|  |  |  | 10 MHz | 20 MHz | 30 MHz | 40 MHz |
| n38, n47 | Power in Transmission Bandwidth Configuration | dBm | PREFSENS\_V2X + channel bandwidth specific value below |
|  | 6 | 9 | 11 | 12 |
|  | PInterferer 1 (CW) | dBm | -46 |
|  | PInterferer 2 (Modulated) | dBm | -46 |
|  | BWInterferer 2 | MHz | 10MHz |
|  | FInterferer 1 (Offset) | MHz | -BW/2 – 15/+BW/2 + 15 |
|  | FInterferer 2 (Offset) | MHz | 2 \* FInterferer 1 |
| NOTE 1: Reference measurement channel is A.7.2NOTE 2: The interferer is QPSK modulated PUSCH containing data and reference symbols. Normal cyclic prefix is used. |

Table 7.8E.2-1a: Wide band intermodulation parameters in n14

|  |  |  |  |
| --- | --- | --- | --- |
| NR band | Rx parameter | Units | Channel bandwidth |
|  |  |  | 5 MHz | 10 MHz | 20 MHz | 30 MHz | 40 MHz |
| n14 | Power in Transmission Bandwidth Configuration | dBm | PREFSENS\_V2X + channel bandwidth specific value below |
|  | 6 | 6 |  |  |  |
|  | PInterferer 1 (CW) | dBm | -46 |
|  | PInterferer 2 (Modulated) | dBm | -46 |
|  | BWInterferer 2 | MHz | 5MHz |
|  | FInterferer 1 (Offset) | MHz | -BW/2 – 7.5/+BW/2 + 7.5 |
|  | FInterferer 2 (Offset) | MHz | 2 \* FInterferer 1 |
| NOTE 1: Reference measurement channel is A.7.2.NOTE 2: The interferer is QPSK modulated PSSCH containing data and reference symbols. Normal cyclic prefix is used. |

### 7.8E.3 Intermodulation for V2X con-current operation

For the inter-band con-current NR V2X operation, the requirements specified in clause 7.8E shall apply for the NR sidelink reception in the operating Bands in in Table 5.2E.1-1 and the requirements specified in clause 7.8 shall apply for the NR downlink reception in licensed band while all downlink carriers are active.

For the intra-band con-current NR V2X operation, the SL carrier is configured with nominal channel spacing to the NR downlink carrier. The minimum requirement specified in clause 7.8A.2.1 shall be applied to the corresponding intra-band con-current V2X UE.

*<Unchanged sections are omitted>*

# A.7 V2X reference measurement channels

## A.7.1 General

The algorithm for determining the payload size A is as follows; given a desired coding rate R and radio block allocation NRB

1. Calculate the RE number of 2nd stage SCI Q\_SCI2^' that can be transmitted in a given sub-frame, where in order to make sure that the code-rate of 2-A is approximate to SCI 1-A, a beta offset is selected based on MCS, and vacant resource elements γ value is determined based on NRB and DMRS frequency density.

2. Transport Block Size is determined according to clause 8.1.3.2 of TS 38.214 [13] based on Table A.7.1-1.

3. Calculate Binary Channel Bits per Slot for PSSCH as below

Binary Channel Bits per Slot = (NRB\* Subcarriers per resource block\*CP-OFDM symbols per slot – DMRS resource REs – PSCCH resource Res - Q\_SCI2^') \* Qm

Where Qm is the modulation order corresponding to MCS.

In Table A.7.1-1 Common reference channel parameters are listed the Sidelink reference measurement channels specified in annexes A.7.2 to A.7.6.

Table A.7.1-1: Common reference channel parameters

|  |  |  |
| --- | --- | --- |
| Parameter | Value | remark |
| Number of HARQ Processes  | 1 |  |
| Channel state | AWGN |  |
| Subcarriers per resource block | 12 |  |
| sl-PSSCH-DMRS-TimePatternList | 2 | symbol4 and symbol 10 in each slotFDMed with PSSCH within DMRS symbolFrequency density is ½ |
| CP-OFDM symbols per slot (Note1) | 12 for all slots | Excluding the first OFDM symbol in one SL slot used for AGC  |
| PSCCH resource | 10 PRBs, 3 symbols in time domain |  |
| Slot number in 10ms | $$10\*2^{μ}$$ | $μ=0,1,2$ for 15kHz, 30kHz, 60kHz |
| PT-RS  | disable |  |
| CSI-RS | disable |  |
| x-overhead | 0 |  |
| PSFCH period | 0 |  |
| 2nd stage SCI payload size | 59 | 35bits SCI-2A + 24bits CRC |
| Redundancy Version | RV0 | For channel coding |
| Alpha value for SCI-2 | 1 |  |

## A.7.2 FRC for V2X receiver requirements for QPSK

For V2X transmission over PC5, Table A.7.2-1, Table A.7.2-2 and Table A.7.2-3 are applicable for measurements on the Receiver Characteristics with the exception of Maximum input level.

Table A.7.2-1: Fixed reference channel for V2X receiver requirements (SCS 15 kHz, QPSK)

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Value |
| Channel bandwidth | MHz | 53 | 10 | 20 | 30 | 40 |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 |
| Subchannel size |  | 12 | 10 | 15 | 10 | 12 |
| Allocated resource blocks |  | 24 | 50 | 105 | 160 | 216 |
| MCS Index |  | 4 | 4 | 4 | 4 | 4 |
| MCS Table for TBS determination | 64QAM |
| Modulation |  | QPSK | QPSK | QPSK | QPSK | QPSK |
| Transport Block Size |  | 1608 | 3624 | 7936 | 12296 | 16896 |
| Transport block CRC | Bits | 16 | 16 | 24 | 24 | 24 |
| LDPC base graph |  | 2 | 2 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  | 1 | 1 | 1 | 2 | 3 |
| Beta offset for 2nd stage SCI |  | 2.25 | 2.25 | 2.25 | 2.25 | 2.25 |
| $γ$ value when 2nd stage SCI rate match |  | 7 | 1 | 1 | 1 | 1 |
| Binary Channel Bits per Slot |  | 5160 | 12036 | 26556 | 41076 | 55860 |
| Max. Throughput averaged over 100ms | Mbps | 0.1608 | 0.3624 | 0.7936 | 1.2296 | 1.6896 |
| NOTE 1: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).NOTE 2: $γ$ is the number of vacant resource elements in the resource block to which the last coded symbol of the 2nd-stage SCI belongs.NOTE 3: The CBW is only applicable for PS UE in n14. |

Table A.7.2-2: Fixed reference channel for V2X receiver requirements (SCS 30 kHz, QPSK)

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Value |
| Channel bandwidth | MHz | 10 | 20 | 30 | 40 |
| Subcarrier spacing | kHz | 30 | 30 | 30 | 30 |
| Subchannel size |  | 12 | 10 | 15 | 15 |
| Allocated resource blocks |  | 24 | 50 | 75 | 105 |
| MCS Index |  | 4 | 4 | 4 | 4 |
| MCS Table for TBS determination | 64QAM |
| Modulation |  | QPSK | QPSK | QPSK | QPSK |
| Transport Block Size |  | 1608 | 3624 | 5632 | 7936 |
| Transport block CRC | Bits | 16 | 16 | 24 | 24 |
| LDPC base graph |  | 2 | 2 | 1 | 1 |
| Number of Code Blocks per Slot |  | 1 | 1 | 1 | 1 |
| Beta offset for 2nd stage SCI |  | 2.25 | 2.25 | 2.25 | 2.25 |
| $γ$ value when 2nd stage SCI rate match |  | 7 | 1 | 1 | 1 |
| Binary Channel Bits per Slot |  | 5160 | 12036 | 18636 | 26556 |
| Max. Throughput averaged over 100ms | Mbps | 0.3216 | 0.7248 | 1.1264 | 1.5872 |
| NOTE 1: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).NOTE 2: $γ$ is the number of vacant resource elements in the resource block to which the last coded symbol of the 2nd-stage SCI belongs. |

Table A.7.2-3: Fixed reference channel for V2X receiver requirements (SCS 60 kHz, QPSK)

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Value |
| Channel bandwidth | MHz | 10 | 20 | 30 | 40 |
| Subcarrier spacing | kHz | 60 | 60 | 60 | 60 |
| Subchannel size |  | 10 | 12 | 12 | 10 |
| Allocated resource blocks |  | 10 | 24 | 36 | 50 |
| MCS Index |  | 4 | 4 | 4 | 4 |
| MCS Table for TBS determination | 64QAM |
| Modulation |  | QPSK | QPSK | QPSK | QPSK |
| Transport Block Size |  | 456 | 1608 | 2536 | 3624 |
| Transport block CRC | Bits | 16 | 16 | 16 | 16 |
| LDPC base graph |  | 2 | 2 | 2 | 2 |
| Number of Code Blocks per Slot |  | 1 | 1 | 1 | 1 |
| Beta offset for 2nd stage SCI |  | 2.25 | 2.25 | 2.25 | 2.25 |
| $γ$ value when 2nd stage SCI rate match |  | 7 | 7 | 7 | 1 |
| Binary Channel Bits per Slot |  | 1464 | 5160 | 8328 | 12036 |
| Max. Throughput averaged over 100ms | Mbps | 0.1824 | 0.6432 | 1.0144 | 1.4496 |
| NOTE 1: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).NOTE 2: $γ$ is the number of vacant resource elements in the resource block to which the last coded symbol of the 2nd-stage SCI belongs. |

## A.7.3 FRC for maximum input level for 64QAM

For V2X transmission over PC5, Table A.7.3-1, Table A.7.3-2 and TableA.7.3-3 are applicable for Maximum input level when the maximum modulation order is 64QAM.

Table A.7.3-1: Fixed reference channel for V2X receiver requirements (SCS 15 kHz, 64QAM)

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Value |
| Channel bandwidth | MHz | 53 | 10 | 20 | 30 | 40 |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 |
| Subchannel size |  | 12 | 10 | 15 | 10 | 12 |
| Allocated resource blocks |  | 24 | 50 | 105 | 160 | 216 |
| MCS Index |  | 24 | 24 | 24 | 24 | 24 |
| MCS Table for TBS determination | 64QAM |
| Modulation |  | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| Transport Block Size |  | 11528 | 27144 | 60456 | 92200 | 127080 |
| Transport block CRC | Bits | 24 | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  | 2 | 4 | 8 | 11 | 16 |
| Beta offset for 2nd stage SCI |  | 6.25 | 6.25 | 6.25 | 6.25 | 6.25 |
| $γ$ value when 2nd stage SCI rate match |  | 7 | 1 | 1 | 1 | 1 |
| Binary Channel Bits per Slot |  | 15336 | 35964 | 79524 | 123084 | 167436 |
| Max. Throughput averaged over 100ms | Mbps | 1.1528 | 2.7144 | 6.0456 | 9.22 | 12.708 |
| NOTE 1: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).NOTE 2: $γ$ is the number of vacant resource elements in the resource block to which the last coded symbol of the 2nd-stage SCI belongs.NOTE 3: The CBW is only applicable for PS UE in n14. |

Table A.7.3-2: Fixed reference channel for V2X receiver requirements (SCS 30 kHz, 64QAM)

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Value |
| Channel bandwidth | MHz | 10 | 20 | 30 | 40 |
| Subcarrier spacing | kHz | 30 | 30 | 30 | 30 |
| Subchannel size |  | 12 | 10 | 15 | 15 |
| Allocated resource blocks |  | 24 | 50 | 75 | 105 |
| MCS Index |  | 24 | 24 | 24 | 24 |
| MCS Table for TBS determination | 64QAM |
| Modulation |  | 64QAM | 64QAM | 64QAM | 64QAM |
| Transport Block Size |  | 11528 | 27144 | 42016 | 60456 |
| Transport block CRC | Bits | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  | 2 | 4 | 5 | 8 |
| Beta offset for 2nd stage SCI |  | 6.25 | 6.25 | 6.25 | 6.25 |
| $γ$ value when 2nd stage SCI rate match |  | 7 | 1 | 1 | 1 |
| Binary Channel Bits per Slot |  | 15336 | 35964 | 55764 | 79524 |
| Max. Throughput averaged over 100ms | Mbps | 2.3056 | 5.4288 | 8.4032 | 12.091 |
| NOTE 1: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).NOTE 2:$ γ$ is the number of vacant resource elements in the resource block to which the last coded symbol of the 2nd-stage SCI belongs. |

TableA.7.3-3: Fixed reference channel for V2X receiver requirements (SCS 60 kHz, 64QAM)

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Value |
| Channel bandwidth | MHz | 10 | 20 | 30 | 40 |
| Subcarrier spacing | kHz | 60 | 60 | 60 | 60 |
| Subchannel size |  | 10 | 12 | 12 | 10 |
| Allocated resource blocks |  | 10 | 24 | 36 | 50 |
| MCS Index |  | 24 | 24 | 24 | 24 |
| MCS Table for TBS determination | 64QAM |
| Modulation |  | 64QAM | 64QAM | 64QAM | 64QAM |
| Transport Block Size |  | 3240 | 11528 | 18960 | 27144 |
| Transport block CRC | Bits | 16 | 24 | 24 | 24 |
| LDPC base graph |  | 2 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  | 1 | 2 | 3 | 4 |
| Beta offset for 2nd stage SCI |  | 6.25 | 6.25 | 6.25 | 6.25 |
| $γ$ value when 2nd stage SCI rate match |  | 7 | 7 | 7 | 1 |
| Binary Channel Bits per Slot |  | 4248 | 15336 | 24840 | 35964 |
| Max. Throughput averaged over 100ms | Mbps | 1.296 | 4.6112 | 7.584 | 10.858 |
| NOTE 1: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).NOTE 2: $γ$ is the number of vacant resource elements in the resource block to which the last coded symbol of the 2nd-stage SCI belongs. |

## A.7.4 FRC for maximum input level for 256QAM

For V2X transmission over PC5, Table A.7.4-1, Table A.7.4-2 and Table A.7.4-3 are applicable for Maximum input level when the 256QAM is supported.

Table A.7.4-1: Fixed reference channel for V2X receiver requirements (SCS 15 kHz, 256QAM)

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Value |
| Channel bandwidth | MHz | 53 | 10 | 20 | 30 | 40 |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 |
| Subchannel size |  | 12 | 10 | 15 | 10 | 12 |
| Allocated resource blocks |  | 24 | 50 | 105 | 160 | 216 |
| MCS Index |  | 23 | 23 | 23 | 23 | 23 |
| MCS Table for TBS determination | 256QAM |
| Modulation |  | 256QAM | 256QAM | 256QAM | 256QAM | 256QAM |
| Transport Block Size |  | 15880 | 36896 | 81976 | 127080 | 172176 |
| Transport block CRC | Bits | 24 | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 1 | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  | 2 | 5 | 10 | 16 | 21 |
| Beta offset for 2nd stage SCI |  | 6.25 | 6.25 | 6.25 | 6.25 | 6.25 |
| $γ$ value when 2nd stage SCI rate match |  | 3 | 3 | 3 | 3 | 3 |
| Binary Channel Bits per Slot |  | 20544 | 48000 | 106080 | 164160 | 223296 |
| Max. Throughput averaged over 100ms | Mbps | 1.588 | 3.6896 | 8.1976 | 12.708 | 17.218 |
| NOTE 1: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).NOTE 2: $γ$ is the number of vacant resource elements in the resource block to which the last coded symbol of the 2nd-stage SCI belongs.NOTE 3: The CBW is only applicable for PS UE in n14. |

Table A.7.4-2: Fixed reference channel for V2X receiver requirements (SCS 30 kHz, 256QAM)

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Value |
| Channel bandwidth | MHz | 10 | 20 | 30 | 40 |
| Subcarrier spacing | kHz | 30 | 30 | 30 | 30 |
| Subchannel size |  | 12 | 10 | 15 | 15 |
| Allocated resource blocks |  | 24 | 50 | 75 | 105 |
| MCS Index |  | 23 | 23 | 23 | 23 |
| MCS Table for TBS determination | 256QAM |
| Modulation |  | 256QAM | 256QAM | 256QAM | 256QAM |
| Transport Block Size |  | 15880 | 36896 | 58384 | 81976 |
| Transport block CRC | Bits | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  | 2 | 5 | 7 | 10 |
| Beta offset for 2nd stage SCI |  | 6.25 | 6.25 | 6.25 | 6.25 |
| $γ$ value when 2nd stage SCI rate match |  | 3 | 3 | 3 | 3 |
| Binary Channel Bits per Slot |  | 20544 | 48000 | 74400 | 106080 |
| Max. Throughput averaged over 100ms | Mbps | 3.176 | 7.3792 | 11.677 | 16.395 |
| NOTE 1: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).NOTE 2: $γ$ is the number of vacant resource elements in the resource block to which the last coded symbol of the 2nd-stage SCI belongs. |

Table A.7.4-3: Fixed reference channel for V2X receiver requirements (SCS 60kHz, 256QAM)

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Value |
| Channel bandwidth | MHz | 10 | 20 | 30 | 40 |
| Subcarrier spacing | kHz | 60 | 60 | 60 | 60 |
| Subchannel size |  | 10 | 12 | 12 | 10 |
| Allocated resource blocks |  | 10 | 24 | 36 | 50 |
| MCS Index |  | 23 | 23 | 23 | 23 |
| MCS Table for TBS determination | 256QAM |
| Modulation |  | 256QAM | 256QAM | 256QAM | 256QAM |
| Transport Block Size |  | 4480 | 15880 | 25608 | 36896 |
| Transport block CRC | Bits | 24 | 24 | 24 | 24 |
| LDPC base graph |  | 1 | 1 | 1 | 1 |
| Number of Code Blocks per Slot |  | 1 | 2 | 4 | 5 |
| Beta offset for 2nd stage SCI |  | 6.25 | 6.25 | 6.25 | 6.25 |
| $γ$ value when 2nd stage SCI rate match |  | 3 | 3 | 3 | 3 |
| Binary Channel Bits per Slot |  | 5760 | 20544 | 33216 | 48000 |
| Max. Throughput averaged over 100ms | Mbps | 1.792 | 6.352 | 10.243 | 14.758 |
| NOTE 1: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).NOTE 2: $γ$ is the number of vacant resource elements in the resource block to which the last coded symbol of the 2nd-stage SCI belongs. |

*<End of Changes>*