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| 3GPP TR 37.878 V18.0.0 (2023-12) | |
| Technical Report | |
| 3rd Generation Partnership Project;  Technical Specification Group Radio Access Network;  Band combinations for con-current operation of NR/LTE Uu  bands/band cobinations and one NR/LTE V2X PC5 band  (Release 18) | |
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| ***3GPP***  Postal address  3GPP support office address  650 Route des Lucioles - Sophia Antipolis  Valbonne - FRANCE  Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16  Internet  http://www.3gpp.org |
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Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

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x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

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y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

# 1 Scope

The present document is the Technical Report on TR on band combinations for con-current operation of NR/LTE Uu bands/band combinations and one NR/LTE V2X band in Release 18.

The purpose of the present document is to study the extension of the band combinations for V2X service to grow the NR V2X ecosystem. Operators propose new band combinations for con-current operation of NR/LTE Uu bands/band combinations and one NR/LTE V2X band. Whether to specify con-current operation of LTE/NR CA/DC band combinations and V2X band depends on requests in Rel-18. Specifically, the self-desensitization problem of con-current operation band combinations will be analysed including harmonics, IMD problem, etc.. Also the candidate solutions will be studied to solve the self-desensitization problem.

Table 1-1: Release 18 NR V2X band combinations

|  |  |
| --- | --- |
| V2X Band combination | REL independent from |
| V2X\_n3-n47 | Rel-16 |
| V2X\_n34-n47 | Rel-16 |
| V2X\_n3\_47 | Rel-16 |
| V2X\_n34\_47 | Rel-16 |
| V2X\_34\_n47 | Rel-16 |

Note: All band combinations in table 1-1 that are release independent from Rel-16 are optional

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] RP-221879: " New WID: Rel-18 band combinations for concurrent operation of NR/LTE Uu bands/band combinations and one NR/LTE V2X PC5 band ".

[3] 3GPP TR 38.886 V16.3.0: " V2X Services based on NR; User Equipment (UE) radio transmission and reception”.

[4] 3GPP TR 38.785 V17.0.0: " User Equipment (UE) radio transmission and reception for enhanced NR sidelink”.

# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

## 3.2 Symbols

For the purposes of the present document, the following symbols apply:

ΔRIB,c Allowed reference sensitivity relaxation due to support for CA or DC operation, for serving cell *c*.

ΔTIB,c Allowed maximum configured output power relaxation due to support for CA or DC operation, for serving cell *c*

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 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 TR 21.905 [1].

CA Carrier Aggregation

CC Component Carrier

DC Dual Connectivity

ITS Intelligent Transportation System

MSD Maximum Sensitivity Degradation

REFSENS Reference Sensitivity

# 4 Background

## 4.1 Justification

3GPP has completed the Release 17 work item on NR V2X including RAN4 minimum requirements and frequency bands for V2X operation. The current specification considers an set of frequency bands for PC5 interface and requirement frame work for con-current operation between Uu bands and V2X bands as part of Release 17 work.

However, in order to further enhance the V2X ecosystem, it is necessary to set up a basket WI to introduce more band combinations on con-current operation of Uu bands and V2X bands in Release 18.

## 4.2 Objective

The objective of this work item is to specify band specific RF requirements for the following scenarios with maximum two simultaneous transmission bands within FR1:

- Con-current operation between NR Uu band and NR PC5 band.

- Con-current operation between LTE Uu band and NR PC5 band.

- Con-current operation between NR Uu band and LTE PC5 band.

- Whether to specify con-current operation of LTE/NR CA/DC band combinations + PC5 V2X band depending on requests in Rel-18.

- If there is such request the denotation on the combination definition need to be discussed at first.

- Analyse con-current operation band combinations that have self-desensitization due to following reasons:

- TX Harmonic and/or inter modulation overlap of receive band

- TX signal overlap of receiver harmonic frequency

- TX frequency being in close proximity of one of the receive bands

- Any other identified reasons

- For the combination where self-desensitization exists, specify at least needed

- ∆TIB and ∆RIB

- Reference sensitivity excerptions

- UL/SL RB restrictions for REFSENS test

- Add conformance testing in RAN5 specifications (to follow at a later stage)

of all REL-18 V2X con-current operation band combinations that fall into the category defined by the WI title.

An overview of these V2X con-current operation band combinations is provided in the attached Excel.

NOTE: Only power class 3 (PC3) is considered in this work item.

# 5 Void

# 6 Con-current operation between one Uu band and one PC5 band

## 6.1 Con-current operation between one LTE Uu band and one NR PC5 band

### 6.1.1 V2X\_34A\_n47A

#### 6.1.1.1 Operating bands for V2X\_34A\_n47A

The operating bands for V2X\_34A\_n47A are specified in table 6.1.1.1-1.

Table 6.1.1.1-1: Inter-band con-current V2X operating bands for V2X\_34A\_n47A

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| V2X con-current configuration | E-UTRA / NR Operating Band | Interface | Uplink (UL) band | | | Downlink (DL) band | | | Duplex Mode |
| BS receive / UE transmit | | | BS transmit / UE receive | | |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | |
| V2X\_34A\_n47A | 34 | Uu | 2010 MHz | – | 2025 MHz | 2010 MHz | – | 2025 MHz | TDD |
| n47 | PC5 | 5855 MHz | – | 5925 MHz | 5855 MHz | – | 5925 MHz | HD |

#### 6.1.1.2 Channel bandwidths per operating band for V2X\_34A\_n47A

The channel bandwidths per operating band for V2X\_34A\_n47A are specified in table 6.1.1.2-1.

Table 6.1.1.2-1: V2X inter-band con-current configurations and bandwidth combination sets for V2X\_34A\_n47A

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| V2X inter-band Configuration | E-UTRA / NR operating Band | SCS kHz | Channel bandwidth (MHz) | Maximum aggregated bandwidth [MHz] | Bandwidth combination set |
| V2X\_34A\_n47A | 34 | 15 | 5, 10, 15 | 55 | 0 |
| n47 | 15 | 10, 20, 30, 40 |
| 30 | 10, 20, 30, 40 |
| 60 | 10, 20, 30, 40 |

#### 6.1.1.3 UE co-existence studies

The UE co-existence studies specified for V2X\_n34A-n47A in clause 6.2.1.3 are applicable to V2X\_34A\_n47A since band 34 and band n34 have the same frequency range.

#### 6.1.1.4 MSD, ∆TIB and ∆RIB values

Table 6.1.1.4-1: ΔTIB,c for inter-band con-current V2X operation (two bands)

|  |  |  |
| --- | --- | --- |
| V2X con-current band Combination | E-UTRA or V2X  Operating Band | ΔTIB,c [dB] |
| V2X\_34A\_n47A | 34 | 0.0 |

Table 6.1.1.4-2: ΔRIB,c for inter-band con-current V2X operation (two bands)

|  |  |  |
| --- | --- | --- |
| V2X inter-band con-current band Combination | E-UTRA Band | ΔRIB,c [dB] |
| V2X\_34A\_n47A | 34 | 0.0 |

## 6.2 Con-current operation between one NR Uu band and one NR PC5 band

### 6.2.1 V2X\_n34A-n47A

#### 6.2.1.1 Operating bands for V2X\_n34A-n47A

The operating bands for V2X\_n34A-n47A are specified in table 6.2.1.1-1.

Table 6.2.1.1-1: Inter-band con-current V2X operating bands for V2X\_n34A-n47A

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| V2X con-current configuration | E-UTRA / NR Operating Band | Interface | Uplink (UL) band | | | Downlink (DL) band | | | Duplex Mode |
| BS receive / UE transmit | | | BS transmit / UE receive | | |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | |
| V2X\_n34A-n47A | n34 | Uu | 2010 MHz | – | 2025 MHz | 2010 MHz | – | 2025 MHz | TDD |
|  | n47 | PC5 | 5855 MHz | – | 5925 MHz | 5855 MHz | – | 5925 MHz | HD |

#### 6.2.1.2 Channel bandwidths per operating band for V2X\_n34A-n47A

The channel bandwidths per operating band for V2X\_n34A-n47A are specified in table 6.2.1.2-1.

Table 6.2.1.2-1: V2X inter-band con-current configurations and bandwidth combination sets for V2X\_n34A-n47A

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| V2X inter-band Configuration | E-UTRA / NR operating Band | SCS kHz | Channel bandwidth (MHz) | Maximum aggregated bandwidth [MHz] | Bandwidth combination set |
| V2X\_n34A\_n47A | n34 | 15 | 5, 10, 15 | 55 | 0 |
| 30 | 10, 15 |
| 60 | 10, 15 |
| n47 | 15 | 10, 20, 30, 40 |
| 30 | 10, 20, 30, 40 |
| 60 | 10, 20, 30, 40 |

#### 6.2.1.3 Coexistence studies

The harmonics analysis for V2X\_n34A-n47A is specified in table 6.2.1.3-1. Up to 4th harmonics of band n34 are provided since the frequency range of the 5th harmonics is much higher than 5.9GHz. The harmonics of band n47 are not listed as the harmonics distributed in the frequency range much higher than 5.9GHz have no impact on GNSS and ISM bands.

Table 6.2.1.3-1: Harmonics analysis for V2X\_n34A-n47A

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Operating Band | Band n34 | | Band n47 | |
| UE UL carriers | fx\_low | fx\_high | fy\_low | fy\_high |
| UL frequency (MHz) | 2010 | 2025 | 5855 | 5925 |
| 2nd harmonics frequency limits | 2\*fx\_low | 2\*fx\_high | No effect | |
| 2nd harmonics frequency limits (MHz) | 4020 | 4050 |
| 3rd harmonics frequency limits | 3\*fx\_low | 3\*fx\_high | No effect | |
| 3rd harmonics frequency limits (MHz) | 6030 | 6075 |
| 4th harmonics frequency limits | 4\*fx\_low | 4\*fx\_high | No effect | |
| 4th harmonics frequency limits (MHz) | 8040 | 8100 |

The IMD analysis for V2X\_n34A-n47A is specified in table 6.2.1.3-2. Up to the 5th order IMDs of band n34 and band n47 are provided. Based on the IMD analysis, it is observed that no IMD products fall into the associated bands.

Table 6.2.1.3-2: IMD analysis for V2X\_n34A-n47A

| Operating Band | Band 34 | | Band n47 | |
| --- | --- | --- | --- | --- |
| UE UL carriers | fx\_low | fx\_high | fy\_low | fy\_high |
| UL frequency (MHz) | 2010 | 2025 | 5855 | 5925 |
| 2nd harmonics frequency limits | 2\*fx\_low | 2\*fx\_high | 2\* fy\_low | 2\* fy\_high |
| 2nd harmonics frequency limits (MHz) | 4020 | 4050 | 11710 | 11850 |
| 3rd harmonics frequency limits | 3\*fx\_low | 3\*fx\_high | 3\* fy\_low | 3\* fy\_high |
| 3rd harmonics frequency limits (MHz) | 6030 | 6075 | 17565 | 17775 |
| Two tone 2nd order IMD products | |fy\_low – fx\_high| | |fy\_high – fx\_low| | |fy\_low + fx\_low| | |fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 3830 | 3915 | 7865 | 7950 |
| Two-tone 3rd order IMD products | |2\*fx\_low – fy\_high| | |2\*fx\_high – fy\_low| | |2\*fy\_low – fx\_high| | |2\*fy\_high – fx\_low| |
| IMD frequency limits (MHz) | 1905 | 1805 | 9685 | 9840 |
| Two-tone 3rd order IMD products | |2\*fx\_low + fy\_low| | |2\*fx\_high + fy\_high| | |2\*fy\_low + fx\_low| | |2\*fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 9875 | 9975 | 13720 | 13875 |
| Two-tone 4th order IMD products | |3\*fx\_low – fy\_high| | |3\*fx\_high – fy\_low| | |3\*fy\_low – fx\_high| | |3\*fy\_high – fx\_low| |
| IMD frequency limits (MHz) | 105 | 220 | 15540 | 15765 |
| Two-tone 4th order IMD products | |3\*fx\_low + fy\_low| | |3\*fx\_high + fy\_high| | |3\*fy\_low + fx\_low| | |3\*fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 11885 | 12000 | 19575 | 19800 |
| Two-tone 4th order IMD products | |2\*fx\_low – 2\*fy\_high| | |2\*fx\_high – 2\*fy\_low| | |2\*fx\_low + 2\*fy\_low| | |2\*fx\_high + 2\*fy\_high| |
| IMD frequency limits (MHz) | 7830 | 7660 | 15730 | 15900 |
| Two-tone 5th order IMD products | |fx\_low – 4\*fy\_high| | |fx\_high – 4\*fy\_low| | |fy\_low – 4\*fx\_high| | |fy\_high – 4\*fx\_low| |
| IMD frequency limits (MHz) | 21690 | 21395 | 2245 | 2115 |
| Two-tone 5th order IMD products | |fx\_low + 4\*fy\_low| | |fx\_high + 4\*fy\_high| | |fy\_low + 4\*fx\_low| | |fy\_high + 4\*fx\_high| |
| IMD frequency limits (MHz) | 25430 | 25725 | 13895 | 14025 |
| Two-tone 5th order IMD products | |2\*fx\_low – 3\*fy\_high| | |2\*fx\_high – 3\*fy\_low| | |2\*fy\_low – 3\*fx\_high| | |2\*fy\_high – 3\*fx\_low| |
| IMD frequency limits (MHz) | 13755 | 13515 | 5635 | 5820 |
| Two-tone 5th order IMD products | |2\*fx\_low + 3\*fy\_low| | |2\*fx\_high + 3\*fy\_high| | |2\*fy\_low + 3\*fx\_low| | |2\*fy\_high + 3\*fx\_high| |
| IMD frequency limits (MHz) | 21585 | 21825 | 17740 | 17925 |

The harmonics and intermodulation products should be evaluated when V2X inter-band con-current operating UE coexists with other systems such as GNSS and ISM. The harmonics and IMD analysis of V2X\_n34A-n47A for GNSS and ISM bands is shown in table 6.2.1.3-3. Based on the analysis for GNSS and ISM bands, band n47 has an impact on the ISM band (5GHz).

Table 6.2.1.3-3: Harmonic and IMDs analysis of V2X\_n34A-n47A UE for GNSS and ISM bands

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Victim Systems | Frequency range [MHz] | | | Impact | Regions | Comments |
| COMPASS  (Beidou) | 1559 | - | 1591 | No |  |  |
| Galileo | 1559 | - | 1591 | No |  |  |
| GLONASS | 1591 | - | 1610 | No |  |  |
| GPS | 1563 | - | 1587 | No |  |  |
| ISM band  (2.4GHz) | 2400 | - | 2483.5 | No | US/Europe |  |
| 2400 | - | 2494 | No | Asia |  |
| ISM band  (5GHz) | 5150 | - | 5925 | Yes | US | 5th IMD, Band n47 |
| 5150 | - | 5350 | Yes | Europe |  |
| 5470 | - | 5725 | Yes | 5th IMD |
| 5150 | - | 5825 | Yes | Asia | 5th IMD |

#### 6.2.1.4 MSD, ∆TIB and ∆RIB values

Table 6.2.1.4-1: ΔTIB,c for inter-band con-current V2X operation (two bands)

|  |  |  |
| --- | --- | --- |
| V2X con-current band Combination | NR  Operating Band | ΔTIB,c [dB] |
| V2X\_n34A-n47A | n34 | 0.0 |

Table 6.2.1.4-2: ΔRIB,c for inter-band con-current V2X operation (two bands)

|  |  |  |
| --- | --- | --- |
| V2X inter-band con-current band Combination | NR Operating Band | ΔRIB,c [dB] |
| V2X\_n34A-n47A | n34 | 0.0 |

### 6.2.2 V2X\_n3A-n47A

#### 6.2.2.1 Operating bands for V2X\_n3A-n47A

The operating bands for V2X\_n3A-n47A are specified in table 6.2.2.1-1.

Table 6.2.2.1-1: Inter-band con-current V2X operating bands for V2X\_n3A-n47A

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| V2X con-current configuration | E-UTRA / NR Operating Band | Interface | Uplink (UL) band | | | Downlink (DL) band | | | Duplex Mode |
| BS receive / UE transmit | | | BS transmit / UE receive | | |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | |
| V2X\_n3A-n47A | n3 | Uu | 1710 MHz | – | 1785 MHz | 1805 MHz | – | 1880 MHz | FDD |
| n47 | PC5 | 5855 MHz | – | 5925 MHz | 5855 MHz | – | 5925 MHz | HD |

#### 6.2.2.2 Channel bandwidths per operating band for V2X\_n3A-n47A

The channel bandwidths per operating band for V2X\_n3A-n47A are specified in table 6.2.2.2-1.

Table 6.2.2.2-1: V2X inter-band con-current configurations and bandwidth combination sets for V2X\_n3A-n47A

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| V2X inter-band Configuration | E-UTRA / NR operating Band | SCS kHz | Channel bandwidth (MHz) | Maximum aggregated bandwidth [MHz] | Bandwidth combination set |
| V2X\_n3A-n47A | n3 | 15 | 5, 10, 15, 20, 25, 30, 35, 40, 45, 50 | 90 | 0 |
| 30 | 10, 15, 20, 25, 30, 35, 40, 45, 50 |
| 60 | 10, 15, 20, 25, 30, 35, 40, 45, 50 |
| n47 | 15 | 10, 20, 30, 40 |
| 30 | 10, 20, 30, 40 |
| 60 | 10, 20, 30, 40 |

#### 6.2.2.3 UE co-existence studies

The harmonics analysis for V2X\_n3A-n47A is specified in table 6.2.2.3-1. Up to the 3rd harmonics of band 3 are provided since the frequency range of the 4th harmonics is higher than 5.9GHz. The harmonics of band n47 are not listed as the harmonics distributed in the frequency range much higher than 5.9GHz have no impact on GNSS and ISM bands. Based on the harmonics analysis, it is observed that the 3rd harmonics of band 3 have no impact on band n47.

Table 6.2.2.3-1: Harmonics analysis for V2X\_n3A-n47A

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Operating Band | Band 3 | | Band n47 | |
| UE UL carriers | fx\_low | fx\_high | fy\_low | fy\_high |
| UL frequency (MHz) | 1710 | 1785 | 5855 | 5925 |
| 2nd harmonics frequency limits | 2\*fx\_low | 2\*fx\_high | No effect | |
| 2nd harmonics frequency limits (MHz) | 3420 | 3570 |
| 3rd harmonics frequency limits | 3\*fx\_low | 3\*fx\_high | No effect | |
| 3rd harmonics frequency limits (MHz) | 5130 | 5355 |

The IMD analysis for V2X\_n3A-n47A is specified in table 6.2.2.3-2. Up to the 5th order IMDs of band 3 and band n47 are provided. Based on the IMD analysis, it is observed that no IMD products fall into the associated bands. So there is no IMD issue causeds by the band combination.

Table 6.2.2.3-2: IMD analysis for V2X\_n3A-n47A

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Operating Band | Band 3 | | Band n47 | |
| UE UL carriers | fx\_low | fx\_high | fy\_low | fy\_high |
| UL frequency (MHz) | 1710 | 1785 | 5855 | 5925 |
| 2nd harmonics frequency limits | 2\*fx\_low | 2\*fx\_high | 2\* fy\_low | 2\* fy\_high |
| 2nd harmonics frequency limits (MHz) | 3420 | 3570 | 11710 | 11850 |
| 3rd harmonics frequency limits | 3\*fx\_low | 3\*fx\_high | 3\* fy\_low | 3\* fy\_high |
| 3rd harmonics frequency limits (MHz) | 5130 | 5355 | 17565 | 17775 |
| Two tone 2nd order IMD products | |fy\_low – fx\_high| | |fy\_high – fx\_low| | |fy\_low + fx\_low| | |fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 4070 | 4215 | 7565 | 7710 |
| Two-tone 3rd order IMD products | |2\*fx\_low – fy\_high| | |2\*fx\_high – fy\_low| | |2\*fy\_low – fx\_high| | |2\*fy\_high – fx\_low| |
| IMD frequency limits (MHz) | 2505 | 2285 | 9925 | 10140 |
| Two-tone 3rd order IMD products | |2\*fx\_low + fy\_low| | |2\*fx\_high + fy\_high| | |2\*fy\_low + fx\_low| | |2\*fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 9275 | 9425 | 13420 | 13635 |
| Two-tone 4th order IMD products | |3\*fx\_low – fy\_high| | |3\*fx\_high – fy\_low| | |3\*fy\_low – fx\_high| | |3\*fy\_high – fx\_low| |
| IMD frequency limits (MHz) | 795 | 500 | 15780 | 16065 |
| Two-tone 4th order IMD products | |3\*fx\_low + fy\_low| | |3\*fx\_high + fy\_high| | |3\*fy\_low + fx\_low| | |3\*fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 10985 | 11280 | 19275 | 19560 |
| Two-tone 4th order IMD products | |2\*fx\_low – 2\*fy\_high| | |2\*fx\_high – 2\*fy\_low| | |2\*fx\_low + 2\*fy\_low| | |2\*fx\_high + 2\*fy\_high| |
| IMD frequency limits (MHz) | 8430 | 8140 | 15130 | 15420 |
| Two-tone 5th order IMD products | |fx\_low – 4\*fy\_high| | |fx\_high – 4\*fy\_low| | |fy\_low – 4\*fx\_high| | |fy\_high – 4\*fx\_low| |
| IMD frequency limits (MHz) | 21990 | 21635 | 1285 | 915 |
| Two-tone 5th order IMD products | |fx\_low + 4\*fy\_low| | |fx\_high + 4\*fy\_high| | |fy\_low + 4\*fx\_low| | |fy\_high + 4\*fx\_high| |
| IMD frequency limits (MHz) | 25130 | 25485 | 12695 | 13065 |
| Two-tone 5th order IMD products | |2\*fx\_low – 3\*fy\_high| | |2\*fx\_high – 3\*fy\_low| | |2\*fy\_low – 3\*fx\_high| | |2\*fy\_high – 3\*fx\_low| |
| IMD frequency limits (MHz) | 14355 | 13995 | 6355 | 6720 |
| Two-tone 5th order IMD products | |2\*fx\_low + 3\*fy\_low| | |2\*fx\_high + 3\*fy\_high| | |2\*fy\_low + 3\*fx\_low| | |2\*fy\_high + 3\*fx\_high| |
| IMD frequency limits (MHz) | 20985 | 21345 | 16840 | 17205 |

The harmonics and intermodulation products should be evaluated when V2X inter-band con-current operating UE coexists with other systems such as GNSS and ISM. The harmonics and IMD analysis of V2X\_n3A-n47A for GNSS and ISM bands is shown in table 6.2.2.3-3. Based on the analysis for GNSS and ISM bands, band n47 and the 3rd harmonics of band 3 have an impact on the ISM band (5GHZ).

Table 6.2.2.3-3: Harmonic and IMDs analysis of V2X\_n3A-n47A UE for GNSS and ISM bands

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Victim Systems | Frequency range [MHz] | | | Impact | Regions | Comments |
| COMPASS  (Beidou) | 1559 | - | 1591 | No |  |  |
| Galileo | 1559 | - | 1591 | No |  |  |
| GLONASS | 1591 | - | 1610 | No |  |  |
| GPS | 1563 | - | 1587 | No |  |  |
| ISM band  (2.4GHz) | 2400 | - | 2483.5 | No | US/Europe |  |
| 2400 | - | 2494 | No | Asia |  |
| ISM band  (5GHz) | 5150 | - | 5925 | Yes | US | Band n47 and 3rd harmonics of band 3 |
| 5150 | - | 5350 | Yes | Europe | 3rd harmonics of band 3 |
| 5470 | - | 5725 | Yes |  |
| 5150 | - | 5825 | Yes | Asia | 3rd harmonics of band 3 |

#### 6.2.2.4 MSD, ∆TIB and ∆RIB values

Table 6.2.2.4-1: ΔTIB,c for inter-band con-current V2X operation (two bands)

|  |  |  |
| --- | --- | --- |
| V2X con-current band Combination | NR  Operating Band | ΔTIB,c [dB] |
| V2X\_n3A-n47A | n3 | 0.0 |

Table 6.2.2.4-2: ΔRIB,c for inter-band con-current V2X operation (two bands)

|  |  |  |
| --- | --- | --- |
| V2X inter-band con-current band Combination | NR Operating Band | ΔRIB,c [dB] |
| V2X\_n3A-n47A | n3 | 0.0 |

## 6.3 Con-current operation between one NR Uu band and one LTE PC5 band

### 6.3.1 V2X\_n34A\_47A

#### 6.3.1.1 Operating bands for V2X\_n34A\_47A

The operating bands for V2X\_n34A\_47A are specified in table 6.3.1.1-1.

Table 6.3.1.1-1: Inter-band con-current V2X operating bands for V2X\_n34A\_47A

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| V2X con-current configuration | E-UTRA / NR Operating Band | Interface | Uplink (UL) band | | | Downlink (DL) band | | | Duplex Mode |
| BS receive / UE transmit | | | BS transmit / UE receive | | |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | |
| V2X\_n34A\_47A | n34 | Uu | 2010 MHz | – | 2025 MHz | 2010 MHz | – | 2025 MHz | TDD |
| 47 | PC5 | 5855 MHz | – | 5925 MHz | 5855 MHz | – | 5925 MHz | HD |

#### 6.3.1.2 Channel bandwidths per operating band for V2X\_n34A\_47A

The channel bandwidths per operating band for V2X\_n34A\_47A are specified in table 6.3.1.2-1.

Table 6.3.1.2-1: V2X inter-band con-current configurations and bandwidth combination sets for V2X\_n34A\_47A

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| V2X inter-band Configuration | E-UTRA / NR operating Band | SCS kHz | Channel bandwidth (MHz) | Maximum aggregated bandwidth [MHz] | Bandwidth combination set |
| V2X\_n34A\_47A | n34 | 15 | 5, 10, 15 | 35 | 0 |
| 30 | 10, 15 |
| 60 | 10, 15 |
| 47 | 15 | 10, 20 |

#### 6.3.1.3 UE co-existence studies

The UE co-existence studies specified for V2X\_n34A-n47A in clause 6.2.1.3 are applicable to V2X\_n34A\_47A since band 47 and band n47 have the same frequency range.

#### 6.3.1.4 MSD, ∆TIB and ∆RIB values

Table 6.3.1.4-1: ΔTIB,c for inter-band con-current V2X operation (two bands)

|  |  |  |
| --- | --- | --- |
| V2X con-current band Combination | NR  Operating Band | ΔTIB,c [dB] |
| V2X\_n34A\_47A | n34 | 0.0 |

Table 6.3.1.4-2: ΔRIB,c for inter-band con-current V2X operation (two bands)

|  |  |  |
| --- | --- | --- |
| V2X inter-band con-current band Combination | NR Operating Band | ΔRIB,c [dB] |
| V2X\_n34A\_47A | n34 | 0.0 |

### 6.3.2 V2X\_n3A\_47A

#### 6.3.2.1 Operating bands for V2X\_n3A\_47A

The operating bands for V2X\_n3A\_47A are specified in table 6.3.2.1-1.

Table 6.3.2.1-1: Inter-band con-current V2X operating bands for V2X\_n3A\_47A

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| V2X con-current configuration | E-UTRA / NR Operating Band | Interface | Uplink (UL) band | | | Downlink (DL) band | | | Duplex Mode |
| BS receive / UE transmit | | | BS transmit / UE receive | | |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | |
| V2X\_n3A\_47A | n3 | Uu | 1710 MHz | – | 1785 MHz | 1805 MHz | – | 1880 MHz | FDD |
| 47 | PC5 | 5855 MHz | – | 5925 MHz | 5855 MHz | – | 5925 MHz | HD |

#### 6.3.2.2 Channel bandwidths per operating band for V2X\_n3A\_47A

The channel bandwidths per operating band for V2X\_n3A\_47A are specified in table 6.3.2.2-1.

Table 6.3.2.2-1: V2X inter-band con-current configurations and bandwidth combination sets for V2X\_n3A\_47A

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| V2X inter-band Configuration | E-UTRA / NR operating Band | SCS kHz | Channel bandwidth (MHz) | Maximum aggregated bandwidth [MHz] | Bandwidth combination set |
| V2X\_n3A\_47A | n3 | 15 | 5, 10, 15, 20, 25, 30, 35, 40, 45, 50 | 70 | 0 |
| 30 | 10, 15, 20, 25, 30, 35, 40, 45, 50 |
| 60 | 10, 15, 20, 25, 30, 35, 40, 45, 50 |
| 47 | 15 | 10, 20 |

#### 6.3.2.3 UE co-existence studies

The UE co-existence studies specified for V2X\_n3A-n47A in clause 6.2.2.3 are applicable to V2X\_n3A\_47A since band 47 and band n47 have the same frequency range.

#### 6.3.2.4 MSD, ∆TIB and ∆RIB values

Table 6.3.2.4-1: ΔTIB,c for inter-band con-current V2X operation (two bands)

|  |  |  |
| --- | --- | --- |
| V2X con-current band Combination | NR  Operating Band | ΔTIB,c [dB] |
| V2X\_n3A\_47A | n3 | 0.0 |

Table 6.3.2.4-2: ΔRIB,c for inter-band con-current V2X operation (two bands)

|  |  |  |
| --- | --- | --- |
| V2X inter-band con-current band Combination | NR Operating Band | ΔRIB,c [dB] |
| V2X\_n3A\_47A | n3 | 0.0 |

# 7 Void

Annex A:  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2022-08 | RAN4 #104e | R4-2214902 |  |  |  | Create the TR skeleton | 0.0.1 |
| 2022-10 | RAN4 #104bis-e | R4-2217812 |  |  |  | Capture the following approved TPs:  R4-2217114 TP for V2X\_n34A-n47A\_V2X\_34A-n47A\_V2X\_n34A-47A  R4-2217115 TP on coexistence study of V2X\_n3A-n47A and V2X\_n3A\_47A | 0.1.0 |
| 2022-11 | RAN4 #105 | R4-2218442 |  |  |  | Capture the following approved TP:  R4-2218198 TP updates for TR37.878 | 0.2.0 |
| 2023-12 | RAN#102 | RP-234066 |  |  |  | Presented to TSG RAN for approval (specification v1.0.0). | 1.0.0 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2023-12 | RAN#102 |  |  |  |  | Approved by plenary – Rel-18 spec under change control | 18.0.0 |