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| 3GPP TR 38.XXX-XX-XX V0.1.0 (2022-08) | |
| Technical Report | |
| 3rd Generation Partnership Project;  Technical Specification Group Radio Access Network;  Rel-18 NR Inter-band Carrier Aggregation/Dual Connectivity for2 bands DL with x bands UL (x=1,2)  (Release 18) | |
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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

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

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.

In the present document, modal verbs have the following meanings:

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

**can** indicates that something is possible

**cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

**will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

# 1 Scope

The present document is a technical report for power class 3 NR inter-band CA and DC for 2 bands DL with up to 2 bands UL under Rel-18 time frame. The purpose is to gather the relevant background information and studies in order to address NR inter-band CA and DC for 2 bands DL with up to 2 bands UL for the Rel-18 band combinations.

This TR contains the RF requirements of band specific combination part. The actual requirements are added to the corresponding technical specifications.

# 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] 3GPP TS 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".

[3] 3GPP TS 38.101-2: "NR; User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone".

[4] 3GPP TS 38.101-3: "NR; User Equipment (UE) radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios".

# 3 Definitions of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms 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].

**Carrier aggregation**: Aggregation of two or more component carriers in order to support wider transmission bandwidths.

**Inter-band carrier aggregation:** Carrier aggregation of component carriers in different operating bands.

NOTE: Carriers aggregated in each band can be contiguous or non-contiguous.

## 3.2 Symbols

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

ΔRIB,c Allowed reference sensitivity relaxation due to support for inter-band CA operation, for serving cell *c*

ΔTIB,c Allowed maximum configured output power relaxation due to support for inter-band CA operation, inter-band NR-DC operation and due to support for SUL operations, 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].

BS Base Station

CA Carrier Aggregation

DC Dual Connectivity

DL DownLink

FDD Frequency Division Duplex

IMD Inter-modulation

MSD Maximum Sensitivity Deduction

SCS Subcarrier spacing

TDD Time Division Duplex

UE User Equipment

UL UpLink

# 4 Background

## 4.1 Introduction

The present document is a technical report for NR inter-band CA and DC for 3 bands DL with 2 bands UL under Rel-17 time frame. The document covers the RF requirements for each band combination specific issues (i.e. one sub-clause defined per band combination), including:

1: Common issues for both 1 band UL and 2 bands UL NR CA, including the impact of UL/DL harmonic/ harmonic mixing associated with REFSEN, delta Tib and delta Rib, and OOB blocking exception, etc.

2: 2 bands UL NR CA specific issues, including MSD caused by IMD issue, etc.

It shall be noted that no new issue for inter-band NR DC combination, the 2 bands UL NR CA specific issues shall be re-used.

## 4.2 TR Maintenance

A single company is responsible for introducing all approved TPs in the current TR, i.e. TR editor. However, it is the responsibility of the contact person of each band combination to ensure that the TPs related to the band combination have been implemented.

Editor's note: It is not recommended to bring TP to TR for the following cases:

1. NR CA configurations with additional BCS other than BCS0(such as BCS1) if there is no additional technical issue.

2. High order DL NR CA configurations, such as DL NR CA configuration CA\_nXA-nYC

# 5 Both bands within FR1 Carrier Aggregation: Specific Band Combination Part

## 5.x CA\_nX-nY

### 5.x.1 Common for 1 band UL and 2 bands UL CA

#### 5.x.1.1 Operating bands for CA

Table 5.x.1.1-1: CA band combination of band nX+nY

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| NR Band | Uplink (UL) band | | | Downlink (DL) band | | | Duplex  mode |
| BS receive / UE transmit | | | BS transmit / UE receive | | |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | |
| nX |  | – |  |  | – |  |  |
| nY |  | – |  |  | – |  |  |
| NOTE X:  Editor's note: Whether or not supporting simultaneous Rx/Tx capability should be identified for TDD-TDD or FDD-TDD band combination | | | | | | | |

#### 5.x.1.2 Channel bandwidths per operating band for CA

Table 5.x.1.2-1: Supported bandwidths per CA band combination of band nX+nY

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR CA configuration | Uplink CA configuration or single uplink carrier | NR Band | Channel bandwidth (MHz) | Bandwidth combination set |
| CA\_nXA-nYA | - \*  or  CA\_nXA-nYA | nX | 5, 10, 15, 20 | 0 |
|  |  | nY | 5, 10, 15, 20, 25, 30 |  |

Editor's note\*: ‘-’ is for 1UL

Editor's note: The table format can be referred to Table 5.5A.3.1-1 in TS38.101-1

#### 5.x.1.3 UE co-existence studies

Table 5.x.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA\_ nX-nY.

**Table 5.x.1.3-1: Impact of UL/DL Harmonic**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **2nd Harmonic** | | **3rd Harmonic** | | **4th Harmonic** | | **5th Harmonic** | |
| **Band** | **UL Low Band Edge** | UL High Band Edge | **DL Low Band Edge** | DL High Band Edge | UL Low Band Edge | UL High Band Edge | UL Low Band Edge | UL High Band Edge | UL Low Band Edge | UL High Band Edge | UL Low Band Edge | UL High Band Edge |
| nX |  |  |  |  |  |  |  |  |  |  |  |  |
| nY |  |  |  |  |  |  |  |  |  |  |  |  |

**Table 5.x.1.3-2: Impact of UL/DL Harmonic mixing**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **2nd Harmonic** | | **3rd Harmonic** | | **4th Harmonic** | | **5th Harmonic** | |
| **Band** | **UL Low Band Edge** | UL High Band Edge | DL Low Band Edge | DL High Band Edge | DL Low Band Edge | DL High Band Edge | DL Low Band Edge | DL High Band Edge | DL Low Band Edge | DL High Band Edge | DL Low Band Edge | DL High Band Edge |
| nX |  |  |  |  |  |  |  |  |  |  |  |  |
| nY |  |  |  |  |  |  |  |  |  |  |  |  |

#### 5.x.1.4 ∆TIB,c and ∆RIB,c values

Editor’s note: for the table of ∆TIB,c and ∆RIB,c values, please use the same table format as in the latest TS 38.101-1, the table below is from the latest Rel.17 38.101-1, note that the table format might be changed in Rel.18.

For CA\_nX-nY, the ΔTIB,c and ΔRIB,c values are given in the tables below.

Table 5.x.1.4-1: ΔTIB,c

| Inter-band CA Configuration | NR Band | ΔTIB,c [dB] |
| --- | --- | --- |
| CA\_nX-nY | nX |  |
|  | nY |  |

Table 5.x.1.4-2: ΔRIB,c

| Inter-band CA Configuration | NR Band | ΔRIB,c [dB] |
| --- | --- | --- |
| CA\_nX-nY | nX |  |
|  | nY |  |

#### 5.x.1.5 REFSENS requirements

Editor's note 1: Text will be added if harmonics and/or harmonic mixing, cross band isolation, etc. issues are identified, and Reference sensitivity exceptions for bands have these issues need to be provided in the table.

Editor's note 2: The table format shall be the same with the corresponding tables in TS38.101-1, i.e.: Table 7.3A.4-1, Table 7.3A.4-4, Table 7.3A.6-1 for harmonics, harmonic mixing and cross band isolation, respectively.

#### 5.x.1.6 OOB blocking exception requirements

Editor's note: The necessary analysis on the OOB blocking exception will be needed.

Table 5.x.1.6-1: CA band combination with exceptions allowed

|  |
| --- |
| CA band combination |
|  |

### 5.x.2 Specific for 2 bands UL CA

Editor's note: Text will be added if 2 bands UL CA are supported, otherwise all the clauses shall be void.

#### 5.x.2.1 Maximum output power for inter-band CA

**Table 5.x.2.1-1: UE Power Class for uplink inter-band CA**

|  |  |  |
| --- | --- | --- |
| Uplink CA Configuration | Class 3 (dBm) | Tolerance (dB) |
| CA\_nXA-nYA | 23 | +x/-y |

#### 5.x.2.2 UE co-existence studies

Table 5.x.2.2-1 lists Band nX + Band nY 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

**Table 5.x.2.2-1: Band nX and Band nY UL IMD products**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| UE UL carriers | fx\_low | fx\_high | | fy\_low | fy\_high | |
| 2nd order IMD products | |fy\_low – fx\_high| | |fy\_high – fx\_low| | | |fy\_low + fx\_low| | |fy\_high + fx\_high| | |
| IMD frequency limits (MHz) | – | | | – | | |
| 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) | – | | | – | | |
| 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) | – | | | – | | |
| Two-tone 3rd order IMD products | (fx\_low – max BW fy) | | (fx\_high + max BW fy) | (fy\_low – max BW fx) | | (fy\_high + max BW fx) |
| IMD frequency limits (MHz) | – | | | – | | |
| Two-tone 4th order IMD products | |3\*fx\_low –1\* fy\_high| | | |3\*fx\_high – 1\*fy\_low| | |3\*fy\_low – 1\*fx\_high| | | |3\*fy\_high – 1\*fx\_low| |
| IMD frequency limits (MHz) | – | | | – | | |
| Two-tone 4th order IMD products | |2\*fx\_low –2\* fy\_high| | | |2\*fx\_high –2\* fy\_low| |  | |  |
| IMD frequency limits (MHz) | – | | |  | | |
| Two-tone 4th order IMD products | |3\*fx\_low +1\* fy\_low| | | |3\*fx\_high + 1\*fy\_high| | |3\*fy\_low + 1\*fx\_low| | | |3\*fy\_high + 1\*fx\_high| |
| IMD frequency limits (MHz) | – | | | – | | |
| Two-tone 4th order IMD products | |2\*fx\_low +2\* fy\_low| | | |2\*fx\_high +2\* fy\_high| |  | |  |
| IMD frequency limits (MHz) | – | | |  | | |
| 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) | – | | | – | | |
| 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) | – | | | – | | |
| 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) | – | | | – | | |
| 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) | – | | | – | | |
| NOTE : For each IMD item, when two bound values before taking absolute have different signs, the relevant IMD range shall be set such that (1) the lower bound is 0 and (2) the upper bound is the bigger value of the two after taking absolute. | | | | | | |

Based on Table 5.x.2.2-1, nth order IMD may also fall into Rx frequencies of bands nX or band nY.

Table 5.x.2.2-2 lists the protected bands required for the 2UL bands CA configuration.

**Table 5.x.2.2-2: Protected bands for the 2UL bands CA configuration**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **NR CA Configuration** | **Spurious emission** | | | | | | |
| **Protected band** | **Frequency range (MHz)** | | | **Maximum Level (dBm)** | **MBW (MHz)** | **NOTE** |
| CA\_nX-nY | E-UTRA Band ..... | FDL\_low | - | FDL\_high |  |  | x |
| Frequency range |  | - |  |  |  |  |
| NOTE x: .....  Editor's note: The NOTE order must keep consistent with the Table 6.5A.3.2.3-1 in TS38.101-1. | | | | | | | |

#### 5.x.2.3 REFSENS requirements

Editor's note: Text will be added if IMD due to 2 bands UL issues are identified.

## 5.1 n1-n26

### 5.1.1 Common for 1 band UL and 2 bands UL CA

#### 5.1.1.1 Operating bands for CA

Table 5.1.1.1-1: CA band combination of band n1 and n26

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| NR Band | Uplink (UL) band | | | Downlink (DL) band | | | Duplex  mode |
| BS receive / UE transmit | | | BS transmit / UE receive | | |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | |
| n1 | 1920 MHz | – | 1980 MHz | 2110 MHz | – | 2170 MHz | FDD |
| n26 | 814 MHz | – | 849 MHz | 859 MHz | – | 894 MHz | FDD |

#### 5.1.1.2 Channel bandwidths per operating band for CA

Table 5.1.1.2-1: Supported bandwidths per CA band combination of band n1+n26

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR CA configuration | Uplink CA configuration or single uplink carrier | NR Band | Channel bandwidth (MHz) | Bandwidth combination set |
| CA\_n1A-n26A | CA\_n1A-n26A | n1 | 5, 10, 15, 20 | 0 |
|  |  | n26 | 5, 10, 15, 20 |  |

#### 5.1.1.3 UE co-existence studies

Table 5.1.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA\_ n1-n26. It is shown that there are no harmonic issues to consider.

**Table 5.1.1.3-1: Impact of UL/DL Harmonic**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **2nd Harmonic** | | **3rd Harmonic** | | **4th Harmonic** | | **5th Harmonic** | |
| **Band** | **UL Low Band Edge** | UL High Band Edge | **DL Low Band Edge** | DL High Band Edge | UL Low Band Edge | UL High Band Edge | UL Low Band Edge | UL High Band Edge | UL Low Band Edge | UL High Band Edge | UL Low Band Edge | UL High Band Edge |
| n1 | 1920 | 1980 | 2110 | 2170 | 3840 | 3960 | 5760 | 5940 | 7680 | 7920 | 9600 | 9900 |
| n26 | 814 | 849 | 859 | 894 | 1628 | 1698 | 2442 | 2547 | 3256 | 3396 | 4070 | 4245 |

**Table 5.1.1.3-2: Impact of UL/DL Harmonic mixing**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **2nd Harmonic** | | **3rd Harmonic** | | **4th Harmonic** | | **5th Harmonic** | |
| **Band** | **UL Low Band Edge** | UL High Band Edge | DL Low Band Edge | DL High Band Edge | DL Low Band Edge | DL High Band Edge | DL Low Band Edge | DL High Band Edge | DL Low Band Edge | DL High Band Edge | DL Low Band Edge | DL High Band Edge |
| n1 | 1920 | 1980 | 2110 | 2170 | 4220 | 4340 | 6330 | 6510 | 8440 | 8680 | 10550 | 10850 |
| n26 | 814 | 849 | 859 | 894 | 1718 | 1788 | 2577 | 2682 | 3436 | 3576 | 4295 | 4470 |

#### 5.1.1.4 ∆TIB and ∆RIB values

For CA\_n1-n26, the ΔTIB,c and ΔRIB,c values are same as for DC\_1\_n5 and are given in the tables below.

**Table 5.1.1.4-1: ΔTIB,c**

| NR CA Configuration | NR Band | ΔTIB,c [dB] |
| --- | --- | --- |
| CA\_n1-n26 | n1 | 0.3 |
| n26 | 0.3 |

**Table 5.1.1.4-2: ΔRIB,c**

| NR CA Configuration | NR Band | ΔRIB,c [dB] |
| --- | --- | --- |
| CA\_n1-n26 | n1 | 0 |
| n26 | 0 |

#### 5.1.1.5 REFSENS requirements

As can be seen in the co-existence studies in 5.1.1.3 there are no harmonics issues.

#### 5.1.1.6 OOB blocking exception requirements

There is no OOB exception for this CA combination.

Table 5.1.1.6-1: CA band combination with exceptions allowed

|  |
| --- |
| CA band combination |
|  |

### 5.1.2 Specific for 2 bands UL CA

#### 5.1.2.1 Maximum output power for inter-band CA

**Table 5.1.2.1-1: UE Power Class for uplink inter-band CA**

|  |  |  |
| --- | --- | --- |
| Uplink CA Configuration | Class 3 (dBm) | Tolerance (dB) |
| CA\_n1A-n26A | 23 | +2/-3 |

#### 5.1.2.2 UE co-existence studies

Table 5.1.2.2-1 lists Band n1 + Band n26 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

**Table 5.1.2.2-1: Band n1 and Band n26 UL harmonics and IMD products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UE UL carriers** | **f1\_low** | **f1\_high** | **f2\_low** | **f2\_high** |
| UL frequencies (MHz) | 814 | 849 | 1920 | 1980 |
| 2nd order IMD products | |fy\_high – fx\_low| | |fy\_low – fx\_high| | |fy\_low + fx\_low| | |fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 1166 | 1071 | 2734 | 2829 |
| 3rd order IMD products | |fy\_high – 2\*fx\_low| | |fy\_low – 2\*fx\_high| | |2\*fy\_low – fx\_high| | |2\*fy\_high – fx\_low| |
| IMD frequency limits (MHz) | 352 | 222 | 2991 | 3146 |
| 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) | 3548 | 3678 | 4654 | 4809 |
| 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) | 2332 | 2142 | 5468 | 5658 |
| Two-tone 4th order IMD products | |3\*fx\_low –1\* fy\_high| | |3\*fx\_high – 1\*fy\_low| | |3\*fy\_low – 1\*fx\_high| | |3\*fy\_high – 1\*fx\_low| |
| IMD frequency limits (MHz) | 462 | 627 | 4911 | 5126 |
| Two-tone 4th order IMD products | |3\*fx\_low +1\* fy\_low| | |3\*fx\_high +1\* fy\_high| | |3\*fy\_low + 1\*fx\_low| | |3\*fy\_high + 1\*fx\_high| |
| IMD frequency limits (MHz) | 4362 | 4527 | 6574 | 6789 |
| 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) | 7106 | 6831 | 1476 | 1276 |
| 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) | 8494 | 8769 | 5176 | 5376 |
| 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) | 4312 | 4062 | 1293 | 1518 |
| 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) | 7388 | 7638 | 6282 | 6507 |

Based on the table above it can be seen that IMD4 may affect own Rx frequencies of band n1.

**Table 5.1.2.2-2: Protected bands for the 2UL bands CA configuration**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **UL NR CA Configuration** | **Spurious emission** | | | | | | |
| **Protected band** | **Frequency range (MHz)** | | | **Maximum Level (dBm)** | **MBW (MHz)** | **NOTE** |
| CA\_n1-n26 | E-UTRA Band 1, 3, 5, 7, 11, 18, 19, 21, 26, 31, 40, 42, 43, 50, 51, 65, 73, 74 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 41  NR Band n77, n78, n79 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| E-UTRA Band 34 | FDL\_low | - | FDL\_high | -50 | 1 | 4 |
| Frequency range | 1880 | - | 1895 | -40 | 1 | 4, 6 |
| Frequency range | 1895 | - | 1915 | -15.5 | 5 | 4, 6, 7 |
| Frequency range | 1915 | - | 1920 | +1.6 | 5 | 4, 6, 7 |
| Frequency range | 945 | - | 960 | -50 | 1 |  |
| Frequency range | 703 | - | 799 | -50 | 1 |  |
| Frequency range | 799 | - | 803 | -40 | 1 | 4 |
| NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. 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 (2 MHz + N x LCRB x 180kHz), where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.  NOTE 4: These requirements also apply for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.  NOTE 6: This requirement is applicable for any channel bandwidths within the range 1920 – 1980 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 1927.5 - 1929.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 1930 – 1938 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB.  NOTE 7: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band. | | | | | | | |

#### 5.1.2.3 REFSENS requirements

Based on the co-existence there are potential IMD4 issues into band n1. But it is not possible to define such testpoints. The potential IMD4 issues is with the lowest range in UL band n1 together with the highest range of UL band n26 which would be a hit in mid-range of DL band n1. But a mid-range UL band 1 does not give IMD4 issues.

Furthermore, CA\_1-26 does not have MSD defined, and neither does the equivalent combinations DC\_1\_n5 or DC\_5\_n1. So it is consequential to not have MSD values defined for CA\_n1-n26.

## 5.2 n3-n26

### 5.2.1 Common for 1 band UL and 2 bands UL CA

#### 5.2.1.1 Operating bands for CA

Table 5.2.1.1-1: CA band combination of band n3 and n26

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| NR Band | Uplink (UL) band | | | Downlink (DL) band | | | Duplex  mode |
| BS receive / UE transmit | | | BS transmit / UE receive | | |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | |
| n3 | 1710 MHz | – | 1785 MHz | 1805 MHz | – | 1880 MHz | FDD |
| n26 | 814 MHz | – | 849 MHz | 859 MHz | – | 894 MHz | FDD |

#### 5.2.1.2 Channel bandwidths per operating band for CA

Table 5.2.1.2-1: Supported bandwidths per CA band combination of band n3+n26

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR CA configuration | Uplink CA configuration or single uplink carrier | NR Band | Channel bandwidth (MHz) | Bandwidth combination set |
| CA\_n3A-n26A | CA\_n3A-n26A | n3 | 5, 10, 15, 20, 25, 30, 40 | 0 |
|  |  | n26 | 5, 10, 15, 20 |  |

#### 5.2.1.3 UE co-existence studies

Table 5.2.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA\_ n3-n26. It is shown that there are no harmonic issues to consider.

**Table 5.2.1.3-1: Impact of UL/DL Harmonic**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **2nd Harmonic** | | **3rd Harmonic** | | **4th Harmonic** | | **5th Harmonic** | |
| **Band** | **UL Low Band Edge** | UL High Band Edge | **DL Low Band Edge** | DL High Band Edge | UL Low Band Edge | UL High Band Edge | UL Low Band Edge | UL High Band Edge | UL Low Band Edge | UL High Band Edge | UL Low Band Edge | UL High Band Edge |
| n3 | 1710 | 1785 | 1805 | 1880 | 3420 | 3570 | 5130 | 5355 | 6840 | 7140 | 8550 | 8925 |
| n26 | 814 | 849 | 859 | 894 | 1628 | 1698 | 2442 | 2547 | 3256 | 3396 | 4070 | 4245 |

**Table 5.2.1.3-2: Impact of UL/DL Harmonic mixing**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **2nd Harmonic** | | **3rd Harmonic** | | **4th Harmonic** | | **5th Harmonic** | |
| **Band** | **UL Low Band Edge** | UL High Band Edge | DL Low Band Edge | DL High Band Edge | DL Low Band Edge | DL High Band Edge | DL Low Band Edge | DL High Band Edge | DL Low Band Edge | DL High Band Edge | DL Low Band Edge | DL High Band Edge |
| n3 | 1710 | 1785 | 1805 | 1710 | 3610 | 3760 | 5415 | 5640 | 7220 | 7520 | 9025 | 9400 |
| n26 | 814 | 849 | 859 | 894 | 1718 | 1788 | 2577 | 2682 | 3436 | 3576 | 4295 | 4470 |

#### 5.2.1.4 ∆TIB and ∆RIB values

For CA\_n3-n26, the ΔTIB,c and ΔRIB,c values are same as for CA\_3-26 and are given in the tables below.

**Table 5.2.1.4-1: ΔTIB,c**

| NR CA Configuration | NR Band | ΔTIB,c [dB] |
| --- | --- | --- |
| CA\_n3-n26 | n3 | 0.3 |
| n26 | 0.3 |

**Table 5.2.1.4-2: ΔRIB,c**

| NR CA Configuration | NR Band | ΔRIB,c [dB] |
| --- | --- | --- |
| CA\_n3-n26 | n3 | 0 |
| n26 | 0 |

#### 5.2.1.5 REFSENS requirements

As can be seen in the co-existence studies in 5.2.1.3 there are no harmonics issues.

Based on the co-existence studies there are 2nd harmonic mixing from band n26 DL into band n3 UL. MSD value to be discussed further at upcoming meetings.

Table 5.2.1.5-1: Reference sensitivity exceptions and uplink/downlink configurations due to harmonic mixing from a PC3 aggressor NR UL band for DL NR CA FR1

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UL band** | **DL band** | **UL BW** | **SCS of UL band** | **UL RB Allocation** | **DL BW** | **MSD** | **UL/DL fc condition** | **UL/DL harmonic order** |
| **(MHz)** | **(kHz)** | **LCRB** | **(MHz)** | **(dB)** |
| n3 | n26 | 5 | 15 | 25 (RBstart=0) | 5 | [TBD] | NOTE 4 | UL1/DL2 |

#### 5.2.1.6 OOB blocking exception requirements

There is no OOB exception for this CA combination.

Table 5.2.1.6-1: CA band combination with exceptions allowed

|  |
| --- |
| CA band combination |
|  |

### 5.2.2 Specific for 2 bands UL CA

#### 5.2.2.1 Maximum output power for inter-band CA

**Table 5.2.2.1-1: UE Power Class for uplink inter-band CA**

|  |  |  |
| --- | --- | --- |
| Uplink CA Configuration | Class 3 (dBm) | Tolerance (dB) |
| CA\_n3A-n26A | 23 | +2/-3 |

#### 5.2.2.2 UE co-existence studies

Table 5.2.2.2-1 lists Band n3 + Band n26 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

**Table 5.2.2.2-1: Band n3 and Band n26 UL harmonics and IMD products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UE UL carriers** | **f1\_low** | **f1\_high** | **f2\_low** | **f2\_high** |
| UL frequencies (MHz) | 814 | 849 | 1710 | 1785 |
| 2nd order IMD products | |fy\_high – fx\_low| | |fy\_low – fx\_high| | |fy\_low + fx\_low| | |fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 971 | 861 | 2524 | 2634 |
| 3rd order IMD products | |fy\_high – 2\*fx\_low| | |fy\_low – 2\*fx\_high| | |2\*fy\_low – fx\_high| | |2\*fy\_high – fx\_low| |
| IMD frequency limits (MHz) | 157 | 12 | 2571 | 2756 |
| 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) | 3338 | 3483 | 4234 | 4419 |
| 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) | 1942 | 1722 | 5048 | 5268 |
| Two-tone 4th order IMD products | |3\*fx\_low –1\* fy\_high| | |3\*fx\_high – 1\*fy\_low| | |3\*fy\_low – 1\*fx\_high| | |3\*fy\_high – 1\*fx\_low| |
| IMD frequency limits (MHz) | 657 | 837 | 4281 | 4541 |
| Two-tone 4th order IMD products | |3\*fx\_low +1\* fy\_low| | |3\*fx\_high +1\* fy\_high| | |3\*fy\_low + 1\*fx\_low| | |3\*fy\_high + 1\*fx\_high| |
| IMD frequency limits (MHz) | 4152 | 4332 | 5944 | 6204 |
| 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) | 6326 | 5991 | 1686 | 1471 |
| 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) | 7654 | 7989 | 4966 | 5181 |
| 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) | 3727 | 3432 | 873 | 1128 |
| 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) | 6758 | 7053 | 5862 | 6117 |

Based on the table above it can be seen that IMD4 may affect own Rx frequencies of band n3 and that IMD2 and IMD5 may affect band n26.

**Table 5.2.2.2-2: Protected bands for the 2UL bands CA configuration**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **UL NR CA Configuration** | **Spurious emission** | | | | | | |
| **Protected band** | **Frequency range (MHz)** | | | **Maximum Level (dBm)** | **MBW (MHz)** | **NOTE** |
| CA\_n3-n26 | E-UTRA Band 1, 5, 7, 11, 18, 19, 21, 26, 34, 39, 40, 43, 50, 51, 65, 73, 74 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA band 3 | FDL\_low | - | FDL\_high | -50 | 1 | 4 |
| E-UTRA band 22, 41, 42  NR Band n77, n78, n79 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 3 |
| Frequency range | 703 | - | 799 | -50 | 1 |  |
| Frequency range | 799 | - | 803 | -40 | 1 | 4 |
| Frequency range | 945 | - | 960 | -50 | 1 |  |
| NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. 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 (2 MHz + N x LCRB x 180kHz), where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.  NOTE 3: Applicable when co-existence with PHS system operating in 1884.5 -1915.7 MHz  NOTE 4: These requirements also apply for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth. | | | | | | | |

#### 5.2.2.3 REFSENS requirements

Based on the co-existence there are potential IMD4 issues into band n3 and potential IMD2 and IMD5 issues into band n26. MSD values are reused from CA\_3A-26A.

**Table 5.2.2.3-1: MSD due to IMD issue**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Operating band / Channel bandwidth / NRB / Duplex mode | | | | | | | | Source of IMD |
| NR CA band combination | NR band | UL Fc  (MHz) | UL/DL BW  (MHz) | UL  CLRB | DL Fc (MHz) | MSD  (dB) | Duplex mode |
| CA\_n3-n26 | n3 | 1771 | 5 | 25 | 1866 | 4 | FDD | IMD4 |
| n26 | 838 | 5 | 25 | 883 | N/A | FDD | N/A |
|  | n3 | 1721 | 5 | 25 | 1816 | N/A | FDD | N/A |
| n26 | 838 | 5 | 25 | 883 | 26 | FDD | IMD211 |
| NOTE 11: This band is subject to IMD5 also which MSD is not specified. | | | | | | | | |

## 5.3 n7-n26

### 5.3.1 Common for 1 band UL and 2 bands UL CA

#### 5.3.1.1 Operating bands for CA

Table 5.3.1.1-1: CA band combination of band n7 and n26

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| NR Band | Uplink (UL) band | | | Downlink (DL) band | | | Duplex  mode |
| BS receive / UE transmit | | | BS transmit / UE receive | | |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | |
| n7 | 2500 MHz | – | 2570 MHz | 2620 MHz | – | 2690 MHz | FDD |
| n26 | 814 MHz | – | 849 MHz | 859 MHz | – | 894 MHz | FDD |

#### 5.3.1.2 Channel bandwidths per operating band for CA

Table 5.3.1.2-1: Supported bandwidths per CA band combination of band n7+n26

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR CA configuration | Uplink CA configuration or single uplink carrier | NR Band | Channel bandwidth (MHz) | Bandwidth combination set |
| CA\_n7A-n26A | CA\_n7A-n26A | n7 | 5, 10, 15, 20, 25, 30, 40, 50 | 0 |
|  |  | n26 | 5, 10, 15, 20 |  |
| CA\_n7B-n26A | CA\_n7A-n26A  CA\_n7B | n7 | CA\_n7B\_BCS0 | 0 |
|  |  | n26 | 5, 10, 15, 20 |  |

#### 5.3.1.3 UE co-existence studies

Table 5.3.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA\_ n7-n26. It is shown that there are no harmonic issues to consider.

**Table 5.3.1.3-1: Impact of UL/DL Harmonic**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **2nd Harmonic** | | **3rd Harmonic** | | **4th Harmonic** | | **5th Harmonic** | |
| **Band** | **UL Low Band Edge** | UL High Band Edge | **DL Low Band Edge** | DL High Band Edge | UL Low Band Edge | UL High Band Edge | UL Low Band Edge | UL High Band Edge | UL Low Band Edge | UL High Band Edge | UL Low Band Edge | UL High Band Edge |
| n7 | 2500 | 2570 | 2620 | 2690 | 5000 | 5140 | 7500 | 7710 | 10000 | 10280 | 12500 | 12850 |
| n26 | 814 | 849 | 859 | 894 | 1628 | 1698 | 2442 | 2547 | 3256 | 3396 | 4070 | 4245 |

**Table 5.3.1.3-2: Impact of UL/DL Harmonic mixing**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **2nd Harmonic** | | **3rd Harmonic** | | **4th Harmonic** | | **5th Harmonic** | |
| **Band** | **UL Low Band Edge** | UL High Band Edge | DL Low Band Edge | DL High Band Edge | DL Low Band Edge | DL High Band Edge | DL Low Band Edge | DL High Band Edge | DL Low Band Edge | DL High Band Edge | DL Low Band Edge | DL High Band Edge |
| n7 | 2500 | 2570 | 2620 | 2690 | 5240 | 5380 | 7860 | 8070 | 10480 | 10760 | 13100 | 13450 |
| n26 | 814 | 849 | 859 | 894 | 1718 | 1788 | 2577 | 2682 | 3436 | 3576 | 4295 | 4470 |

#### 5.3.1.4 ∆TIB and ∆RIB values

For CA\_n7-n26, the ΔTIB,c and ΔRIB,c values are same as for CA\_3-26 and are given in the tables below.

**Table 5.3.1.4-1: ΔTIB,c**

| NR CA Configuration | NR Band | ΔTIB,c [dB] |
| --- | --- | --- |
| CA\_n7-n26 | n7 | 0.3 |
| n26 | 0.3 |

**Table 5.3.1.4-2: ΔRIB,c**

| NR CA Configuration | NR Band | ΔRIB,c [dB] |
| --- | --- | --- |
| CA\_n7-n26 | n7 | 0 |
| n26 | 0 |

#### 5.3.1.5 REFSENS requirements

As can be seen in the co-existence studies in 5.3.1.3 there are no harmonics issues.

Based on the co-existence studies there are 3rd harmonic mixing from band n26 DL into band n7 UL. MSD value to be discussed further at upcoming meetings.

Table 5.3.1.5-2: Reference sensitivity exceptions and uplink/downlink configurations due to harmonic mixing from a PC3 aggressor NR UL band for DL NR CA FR1

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UL band** | **DL band** | **UL BW** | **SCS of UL band** | **UL RB Allocation** | **DL BW** | **MSD** | **UL/DL fc condition** | **UL/DL harmonic order** |
| **(MHz)** | **(kHz)** | **LCRB** | **(MHz)** | **(dB)** |
| n7 | n26 | 5 | 15 | 75 (RBstart=0) | 5 | [TBD] | FDL=861.5 MHz FUL=2562 MHz | UL1/DL3 Near miss |

#### 5.3.1.6 OOB blocking exception requirements

There is no OOB exception for this CA combination.

Table 5.3.1.6-1: CA band combination with exceptions allowed

|  |
| --- |
| CA band combination |
|  |

### 5.3.2 Specific for 2 bands UL CA

#### 5.3.2.1 Maximum output power for inter-band CA

**Table 5.3.2.1-1: UE Power Class for uplink inter-band CA**

|  |  |  |
| --- | --- | --- |
| Uplink CA Configuration | Class 3 (dBm) | Tolerance (dB) |
| CA\_n7A-n26A | 23 | +2/-3 |

#### 5.3.2.2 UE co-existence studies

Table 5.3.2.2-1 lists Band n7 + Band n26 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

**Table 5.3.2.2-1: Band n7 and Band n26 UL harmonics and IMD products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UE UL carriers** | **f1\_low** | **f1\_high** | **f2\_low** | **f2\_high** |
| UL frequencies (MHz) | 814 | 849 | 2500 | 2570 |
| 2nd order IMD products | |fy\_high – fx\_low| | |fy\_low – fx\_high| | |fy\_low + fx\_low| | |fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 1756 | 1651 | 3314 | 3419 |
| 3rd order IMD products | |fy\_high – 2\*fx\_low| | |fy\_low – 2\*fx\_high| | |2\*fy\_low – fx\_high| | |2\*fy\_high – fx\_low| |
| IMD frequency limits (MHz) | 942 | 802 | 4151 | 4326 |
| 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) | 4128 | 4268 | 5814 | 5989 |
| 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) | 3512 | 3302 | 6628 | 6838 |
| Two-tone 4th order IMD products | |3\*fx\_low –1\* fy\_high| | |3\*fx\_high – 1\*fy\_low| | |3\*fy\_low – 1\*fx\_high| | |3\*fy\_high – 1\*fx\_low| |
| IMD frequency limits (MHz) | 128 | 47 | 6651 | 6896 |
| Two-tone 4th order IMD products | |3\*fx\_low +1\* fy\_low| | |3\*fx\_high +1\* fy\_high| | |3\*fy\_low + 1\*fx\_low| | |3\*fy\_high + 1\*fx\_high| |
| IMD frequency limits (MHz) | 4942 | 5117 | 8314 | 8559 |
| 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) | 9466 | 9151 | 896 | 686 |
| 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) | 10814 | 11129 | 5756 | 5966 |
| 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) | 6082 | 5802 | 2453 | 2698 |
| 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) | 9128 | 9408 | 7442 | 7687 |

Based on the table above it can be seen that IMD5 may affect own Rx frequencies of band n7 and that IMD3 and IMD5 may affect band n26.

**Table 5.3.2.2-2: Protected bands for the 2UL bands CA configuration**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **UL NR CA Configuration** | **Spurious emission** | | | | | | |
| **Protected band** | **Frequency range (MHz)** | | | **Maximum Level (dBm)** | **MBW (MHz)** | **NOTE** |
| CA\_n7-n26 | E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 12, 13, 14, 17, 22, 26, 29, 30, 31, 40, 42, 43, 65, 66, 85, 103 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| NR Band n77, n78, n79 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| Frequency range | 2570 | - | 2575 | +1.6 | 5 | 4, 7, 8 |
| Frequency range | 2575 | - | 2595 | -15.5 | 5 | 4, 7, 8 |
| Frequency range | 2595 | - | 2620 | -40 | 1 | 4, 14 |
| Frequency range | 703 | - | 799 | -50 | 1 |  |
| Frequency range | 799 | - | 803 | -40 | 1 | 4 |
| Frequency range | 945 | - | 960 | -50 | 1 |  |
| Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 3 |
| NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. 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 (2 MHz + N x LCRB x 180kHz), where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.  NOTE 3: Applicable when co-existence with PHS system operating in 1884.5 -1915.7 MHz  NOTE 4: These requirements also apply for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.  NOTE 7: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.  NOTE 8: This requirement is only applicable for carriers with bandwidth confined within 1885-1920 MHz (requirement for carriers with at least 1RB confined within 1880 - 1885 MHz is not specified). This requirement applies for an uplink transmission bandwidth less than or equal to 54 RB for carriers of 15 MHz bandwidth when carrier center frequency is within the range 1892.5 - 1894.5 MHz and for carriers of 20 MHz bandwidth when carrier center frequency is within the range 1895 - 1903 MHz. | | | | | | | |

#### 5.3.2.3 REFSENS requirements

Based on the co-existence there are potential IMD5 issues into band n7 and potential IMD3 and IMD5 issues into band n26. MSD values are reused from CA\_3A-26A.

**Table 5.3.2.3-1: MSD due to IMD issue**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Operating band / Channel bandwidth / NRB / Duplex mode | | | | | | | | Source of IMD |
| NR CA band combination | NR band | UL Fc  (MHz) | UL/DL BW  (MHz) | UL  CLRB | DL Fc (MHz) | MSD  (dB) | Duplex mode |
| CA\_n7-n26 | n7 | 2556 | 5 | 25 | 2676 | N/A | FDD | N/A |
| n26 | 837 | 5 | 25 | 882 | 16.0 | FDD | IMD311 |
|  | n7 | 2567.5 | 5 | 25 | 2687.5 | 2.5 | FDD | IMD5 |
| n26 | 816.5 | 5 | 25 | 861.5 | N/A | FDD | N/A |
| NOTE 11: This band is subject to IMD5 also which MSD is not specified. | | | | | | | | |

## 5.4 n26-n78

### 5.4.1 Common for 1 band UL and 2 bands UL CA

#### 5.4.1.1 Operating bands for CA

Table 5.4.1.1-1: CA band combination of band n26 and n78

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| NR Band | Uplink (UL) band | | | Downlink (DL) band | | | Duplex  mode |
| BS receive / UE transmit | | | BS transmit / UE receive | | |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | |
| n26 | 814 MHz | – | 849 MHz | 859 MHz | – | 894 MHz | FDD |
| n78 | 3300 MHz | – | 3800 MHz | 3300 MHz | – | 3800 MHz | TDD |

#### 5.4.1.2 Channel bandwidths per operating band for CA

Table 5.4.1.2-1: Supported bandwidths per CA band combination of band n26+n78

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR CA configuration | Uplink CA configuration or single uplink carrier | NR Band | Channel bandwidth (MHz) | Bandwidth combination set |
| CA\_n26A-n78A | CA\_n26A-n78A | n26 | 5, 10, 15, 20 | 0 |
|  |  | n78 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 |  |

#### 5.4.1.3 UE co-existence studies

Table 5.4.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA\_ n26-n78.

**Table 5.4.1.3-1: Impact of UL/DL Harmonic**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **2nd Harmonic** | | **3rd Harmonic** | | **4th Harmonic** | | **5th Harmonic** | |
| **Band** | **UL Low Band Edge** | UL High Band Edge | **DL Low Band Edge** | DL High Band Edge | UL Low Band Edge | UL High Band Edge | UL Low Band Edge | UL High Band Edge | UL Low Band Edge | UL High Band Edge | UL Low Band Edge | UL High Band Edge |
| n26 | 814 | 849 | 859 | 894 | 1628 | 1698 | 2442 | 2547 | 3256 | 3396 | 4070 | 4245 |
| n78 | 3300 | 3800 | 3300 | 3800 | 6600 | 7600 | 9900 | 11400 | 13200 | 15200 | 16500 | 19000 |

**Table 5.4.1.3-2: Impact of UL/DL Harmonic mixing**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **2nd Harmonic** | | **3rd Harmonic** | | **4th Harmonic** | | **5th Harmonic** | |
| **Band** | **UL Low Band Edge** | UL High Band Edge | DL Low Band Edge | DL High Band Edge | DL Low Band Edge | DL High Band Edge | DL Low Band Edge | DL High Band Edge | DL Low Band Edge | DL High Band Edge | DL Low Band Edge | DL High Band Edge |
| n26 | 814 | 849 | 859 | 894 | 1718 | 1788 | 2577 | 2682 | 3436 | 3576 | 4295 | 4470 |
| n78 | 3300 | 3800 | 3300 | 3800 | 6600 | 7600 | 9900 | 11400 | 13200 | 15200 | 16500 | 19000 |

#### 5.4.1.4 ∆TIB and ∆RIB values

For CA\_n26-n78, the ΔTIB,c and ΔRIB,c values are same as for DC\_26\_n78 and are given in the tables below.

**Table 5.4.1.4-1: ΔTIB,c**

| NR CA Configuration | NR Band | ΔTIB,c [dB] |
| --- | --- | --- |
| CA\_n26-n78 | n26 | 0.3 |
| n78 | 0.8 |

**Table 5.4.1.4-2: ΔRIB,c**

| NR CA Configuration | NR Band | ΔRIB,c [dB] |
| --- | --- | --- |
| CA\_n26-n78 | n26 | 0 |
| n78 | 0.5 |

#### 5.4.1.5 REFSENS requirements

As can be seen in the co-existence studies in 5.4.1.3 there are 4th harmonics issues to DL n78. Values are reused from DC\_26\_n78 and CA\_n20-n78.

Table 5.4.1.5-1: Reference sensitivity exceptions due to UL harmonic for NR CA FR1

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UL band** | **DL band** | **UL BW** | **SCS of UL band** | **UL RB Allocation** | **DL BW** | **MSD** | **UL/DL fc condition** | **UL/DL harmonic order** |
| **(MHz)** | **(kHz)** | **LCRB** | **(MHz)** | **(dB)** |
| n26 | n78 | 5 | 15 | 16 (RBstart=0) | 10 | 10.8 | NOTE 4 | UL4/DL1  direct-hit |
| n26 | n78 | 5 | 15 | 25 (RBstart=0) | 100 | 1.4 | NOTE 4 | UL4/DL1  direct-hit |
| NOTE 4: The requirements should be verified for UL EARFCN of the aggressor (lower) band (superscript LB) such that in MHz and  with carrier frequency in the victim (higher) band in MHz and  the channel bandwidth configured in the lower band. | | | | | | | | |

#### 5.4.1.6 OOB blocking exception requirements

Since band n28 is a low band and n78 is a wide band, the OOBB exception is needed.

Table 5.4.1.6-1: CA band combination with exceptions allowed

|  |
| --- |
| CA band combination |
| CA\_n26-n78 |

### 5.4.2 Specific for 2 bands UL CA

#### 5.4.2.1 Maximum output power for inter-band CA

**Table 5.4.2.1-1: UE Power Class for uplink inter-band CA**

|  |  |  |
| --- | --- | --- |
| Uplink CA Configuration | Class 3 (dBm) | Tolerance (dB) |
| CA\_n26A-n78A | 23 | +2/-3 |

#### 5.4.2.2 UE co-existence studies

Table 5.4.2.2-1 lists Band n26 + Band n78 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

**Table 5.4.2.2-1: Band n26 and Band n78 UL harmonics and IMD products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UE UL carriers** | **f1\_low** | **f1\_high** | **f2\_low** | **f2\_high** |
| UL frequencies (MHz) | 814 | 849 | 3300 | 3800 |
| 2nd order IMD products | |fy\_high – fx\_low| | |fy\_low – fx\_high| | |fy\_low + fx\_low| | |fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 2986 | 2451 | 4114 | 4649 |
| 3rd order IMD products | |fy\_high – 2\*fx\_low| | |fy\_low – 2\*fx\_high| | |2\*fy\_low – fx\_high| | |2\*fy\_high – fx\_low| |
| IMD frequency limits (MHz) | 2172 | 1602 | 5751 | 6786 |
| 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) | 4928 | 5498 | 7414 | 8449 |
| 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) | 5972 | 4902 | 8228 | 9298 |
| Two-tone 4th order IMD products | |3\*fx\_low –1\* fy\_high| | |3\*fx\_high – 1\*fy\_low| | |3\*fy\_low – 1\*fx\_high| | |3\*fy\_high – 1\*fx\_low| |
| IMD frequency limits (MHz) | 1358 | 753 | 9051 | 10586 |
| Two-tone 4th order IMD products | |3\*fx\_low +1\* fy\_low| | |3\*fx\_high +1\* fy\_high| | |3\*fy\_low + 1\*fx\_low| | |3\*fy\_high + 1\*fx\_high| |
| IMD frequency limits (MHz) | 5742 | 6347 | 10714 | 12249 |
| 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) | 14386 | 12351 | 96 | 544 |
| 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) | 14014 | 16049 | 6556 | 7196 |
| 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) | 9772 | 8202 | 4053 | 5158 |
| 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) | 11528 | 13098 | 9042 | 10147 |

Based on the table above it can be seen that IMD4 may affect own Rx frequencies of band n26.

**Table 5.4.2.2-2: Protected bands for the 2UL bands CA configuration**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **UL NR CA Configuration** | **Spurious emission** | | | | | | |
| **Protected band** | **Frequency range (MHz)** | | | **Maximum Level (dBm)** | **MBW (MHz)** | **NOTE** |
| CA\_n26-n78 | E-UTRA Band 1, 3, 5, 11, 18, 19, 21, 26, 34, 39, 40, 65, 74 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 41 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| Frequency range | 703 | - | 799 | -50 | 1 |  |
| Frequency range | 799 | - | 803 | -40 | 1 | 4 |
| Frequency range | 945 | - | 960 | -50 | 1 |  |
| Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 3 |
| NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. 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 (2 MHz + N x LCRB x 180kHz), where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.  NOTE 3: Applicable when co-existence with PHS system operating in 1884.5 -1915.7 MHz  NOTE 4: These requirements also apply for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth. | | | | | | | |

#### 5.4.2.3 REFSENS requirements

Based on the co-existence studies the following MSD need to be defined. Values are reused from DC\_26\_n77.

**Table 5.4.2.3-1: MSD due to IMD issue**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Operating band / Channel bandwidth / NRB / Duplex mode | | | | | | | | Source of IMD |
| NR CA band combination | NR band | UL Fc  (MHz) | UL/DL BW  (MHz) | UL  CLRB | DL Fc (MHz) | MSD  (dB) | Duplex mode |
| CA\_n26-n78 | n26 | 836.5 | 5 | 25 | 881.5 | 11.1 | FDD | IMD4 |
| n78 | 3391 | 10 | 50 | 3391 | N/A | TDD | N/A |

# 6 Both bands within FR2 Carrier Aggregation: Specific Band Combination Part

Editor's note: This section is reserved for future used. The template for inter-band FR2 NR CA combination can be referred to TR38.851

# 7 Dual Connectivity: Specific Band Combination Part

## 7.x DC\_nX-nY

Editor's note: The texts for NR DC can only be added associated with the texts for the corresponding inter-band 2 bands UL CA above, which means pure TP to TR to included NR DC configuration is not allowed.

### 7.x.1 Configurations for DC\_nX-nY

Table 7.x.1-1: Inter-band NR DC configurations

| NR DC  configuration | Uplink NR DC  configuration |
| --- | --- |
| DC\_nXA-nYA | DC\_nXA-nYA |

### 7.x.2 Maximum output power for NR-DC

**Table 7.x.2-1: UE Power Class for uplink inter-band DC**

|  |  |  |
| --- | --- | --- |
| Uplink CA Configuration | Class 3 (dBm) | Tolerance (dB) |
| DC\_nXA-nYA | 23 | +x/-y |

Annex <X> (informative):  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Change history | | | | | | | |
| Date | Meeting | TDoc | CR | Rev | Cat | Subject/Comment | New version |
| 2022-08 | RAN4 #104e | R4-2212740 |  |  |  | TR skeleton | 0.0.0 |
| 2022-08 | RAN4 #104e | R4-2212741 |  |  |  | Include the approved TP in #104 meeting:  R4-2215016 TP for TR 38.818-02-01 to include CA\_n1-n26  R4-2215017 TP for TR 38.818-02-01 to include CA\_n3-n26  R4-2215018 TP for TR 38.818-02-01 to include CA\_n7-n26  R4-2215019 TP for TR 38.818-02-01 to include CA\_n26-n78 | 0.1.0 |