3GPP TR 36.716-02-02 V16.0.0 (2020-06)

Technical Report

3rd Generation Partnership Project;

Technical Specification Group Radio Access Networks;

LTE inter-band CA for 2 bands DL with 2 bands UL

(Release 16)



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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:

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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 a technical report on LTE inter-band CA for 2 bands DL with 2 bands UL under Rel-16 time frame. The purpose is to gather the relevant background information and studies in order to address 2 bands DL/2 band UL Inter-band Carrier Aggregation requirements for the Rel-16 band combinations in Table 1-1.

Table 1-1: Release 16 2 bands DL/2 bands UL inter-band carrier aggregation combinations

|  |  |
| --- | --- |
| CA combination | REL independent from |
| CA\_3A-11A | Rel-11 |
| CA\_26A-48C  CA\_26A-48A-48A | Rel-14 |
| CA\_25A-41A  CA\_25A-41C  CA\_25A-41D  CA\_25A-41E  CA\_25A-41F | Rel-12 |
| CA\_25A-25A-41A  CA\_25A-25A-41C  CA\_25A-25A-41D  CA\_25A-25A-41E  CA\_25A-25A-41F | Rel-12 |
| CA\_25A-26A  CA\_25A-25A-26A | Rel-12 |
| CA\_2A-48A  CA\_2A-48A-48A  CA\_2A-48C  CA\_2A-48D  CA\_2A-48A-48C  CA\_2A-48E  CA\_2A-48A-48D  CA\_2A-48A-48E | Rel-11 |
| CA\_2A-14A | Rel-12 |
| CA\_4A-28A | Rel-11 |
| CA\_13A-66A  CA\_13A-66A-66A  CA\_13A-66B  CA\_13A-66C | Rel-11 |
| CA\_14A-30A | Rel-12 |
| CA\_14A-66A | Rel-12 |
| CA\_1A-7A-7A | Rel-11 |
| CA\_2A-5A | Rel-11 |
| CA\_4A-5A | Rel-11 |
| CA\_2A-2A-13A | Rel-11 |
| CA\_1A-41C | Rel-11 |
| CA\_18A-41A | Rel-11 |
| CA\_18A-41C | Rel-11 |

This TR contains a 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] RP-181356, “New WID on Rel-16 LTE inter-band Carrier Aggregation for 2 bands DL with 2 band UL”, RAN#80.

# 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:

<symbol> <Explanation>

## 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].

# 4 Background

The present document is a technical report for 2 bands DL/2 bands UL Inter-band Carrier Aggregation under Rel-16 timeframe. The document covers each band combination specific issues (i.e. one sub-clause defined per band combination)

## 4.1 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.

# 5 2 Bands Carrier Aggregation with 2 Bands UL: Specific Band Combination Part

## 5.1 CA\_3-11

### 5.1.1 Channel bandwidths per operating band for CA

Table 5.1.1-1: Inter-band CA operating bands

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA Band | E-UTRA Band | Uplink (UL) operating band | | | Downlink (DL) operating band | | | Duplex Mode |
| BS receive / UE transmit | | | BS transmit / UE receive | | |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | |
| CA\_3-11 | 3 | 1710 MHz | – | 1785 MHz | 1805 MHz | – | 1880 MHz | FDD |
| 11 | 1427.9 MHz | – | 1447.9 MHz | 1475.9 MHz | – | 1495.9 MHz | TDD |

Table 5.1.1-2: E-UTRA CA configurations and bandwidth combination sets defined for inter-band CA

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA configuration / Bandwidth combination set | | | | | | | | | | |
| E-UTRA CA Configuration | Uplink CA configurations | E-UTRA Bands | 1.4 MHz | 3 MHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | Maximum aggregated bandwidth  [MHz] | Bandwidth combination set |
| CA\_3A-11A | 3A-11A | 3 |  |  | Yes | Yes | Yes | Yes | 30 | 0 |
| 11 |  |  | Yes | Yes |  |  |

### 5.1.2 Co-existence studies

There is no own Rx impact of the 3rd band for this configuration..

Table 5.1.2-1 shows the requirements for the specified carrier aggregation configurations CA\_3A-11A for coexistence with protected bands.

**Table 5.1.2-1: Requirements for uplink inter-band carrier aggregation CA\_3-11**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA Configuration | Spurious emission | | | | | | |
| Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| CA\_3-11 | E-UTRA Band 1, 18, 19, 28, 34, 65 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA band 3 | FDL\_low | - | FDL\_high | -50 | 1 | 3 |
| E-UTRA Band 42 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| Frequency range | 945 | - | 960 | -50 | 1 |  |
| Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 4 |
| Frequency range | 2545 | - | 2575 | -50 | 1 |  |
| Frequency range | 2595 | - | 2645 | -50 | 1 |  |
| NOTE 2: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 3: 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 4:Applicable when co-existence with PHS system operating in 1884.5 -1915.7MHz. | | | | | | | |

### 5.1.3 ∆TIB and ∆RIB values

For 2UL CA\_3-11, the same requirements on values for ∆TIB,c and ∆RIB,c  of 1UL CA\_3-11 can be applied. Therefore, for two simultaneous UL, the ΔTIB,c and ΔRIB,c values are shown in table 5.1.3-1 and in table 5.1.3-2.

Table 5.1.3-1: IB,c

| Inter-band CA Configuration | E-UTRA Band | ΔTIB,c [dB] |
| --- | --- | --- |
| CA\_3-11 | 3 | 0.8 |
| 11 | 0.9 |

Table 5.1.3-2: R IB,c

| Inter-band CA Configuration | E-UTRA Band | ΔRIB,c [dB] |
| --- | --- | --- |
| CA\_3-11 | 3 | 0.3 |
| 11 | 0.5 |

### 5.1.4 REFSENS requirements

No REFSENS requirements are expected for this configuration.

## 5.2 CA\_26-48

### 5.2.1 Channel bandwidths per operating band for CA

Table 5.2.1-1: Supported E-UTRA bandwidths per CA configuration for inter-band CA

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA configuration / Bandwidth combination set | | | | | | | | | | | | | | | | | | | | | |
| E-UTRA CA Configuration | | Uplink CA configurations | | E-UTRA Bands | | 1.4 MHz | | 3 MHz | | 5 MHz | | 10 MHz | | 15 MHz | | 20 MHz | | Maximum aggregated bandwidth  [MHz] | | Bandwidth combination set | |
| CA\_26A-48C | | CA\_26A-48A | | 26 | |  | | Yes | | Yes | | Yes | |  | |  | | 50 | | 0 | |
| 48 | | See CA\_48C Bandwidth combination set 0 in the Table 5.6A.1-1 | | | | | | | | | | | |
| CA\_26A-48A-48A | | CA\_26A-48A | | 26 | |  | | Yes | | Yes | | Yes | |  | |  | | 50 | | 0 | |
| 48 | | See CA\_48A-48A Bandwidth combination set 0 in the Table 5.6A.1-3 | | | | | | | | | | | |

### 5.2.3 Coexistence studies

The UE-UE co-existence studies follow those investigated in TR 36.715-02-02 [2] for DL\_26A-48A\_UL\_ 26A-48A\_BCS0.

### 5.2.2 ΔTIB,c and ΔRIB,c values

Same ΔTIB,c and ΔRIB,c values as in TR 36.715-02-02 [2] for DL\_26A-48A\_UL\_ 26A-48A\_BCS0.

Table 5.2.2-1: ΔTIB,c

|  |  |  |
| --- | --- | --- |
| Inter-band CA Configuration | E-UTRA Band | ΔTIB,c [dB] |
| CA\_26A-48A | 26 | 0.3 |
| 48 | 0,3 |

Table 5.2.2-2: ΔRIB,c

|  |  |  |
| --- | --- | --- |
| Inter-band CA Configuration | E-UTRA Band | ΔRIB,c [dB] |
| CA\_26A-48A | 26 | 0 |
| 48 | 0 |

### 5.2.4 REFSENS requirements

As shown in table 6.8.3.1-2 of the TR 36.715-02-02 [2], IMD up to 5th order does not fall into own Rx of band 26 and 48. Therefore, no MSD requirement is needed for these CA configurations in TS 36.101.

## 5.3 CA\_25-41

### 5.3.1 Channel bandwidths per operating band

Table 5.3.1.-1: CA band combination of band 25 + 41

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| E-Utra 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 | | |
| 25 | 1850 MHz | – | 1915 MHz | 1930 MHz | – | 1995 MHz | FDD |
| 41 | 2496 MHz | – | 2690 MHz | 2496 MHz | – | 2690 MHz | TDD |

Table 5.3.1-2: E-UTRA CA configurations and bandwidth combination sets for UL CA\_25A-41A

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA configuration / Bandwidth combination set | | | | | | | | | | | | | |
| E-UTRA CA Configuration | Uplink CA configurations | E-UTRA Bands | 1.4 MHz | | 3 MHz | 5 MHz | | 10 MHz | 15 MHz | | 20 MHz | Maximum aggregated bandwidth  [MHz] | Bandwidth combination set |
| CA\_25A-41A | CA\_25A-41A | 25 |  | |  | yes | | yes | yes | | yes | 40 | 0 |
| 41 |  | |  | yes | | yes | yes | | yes |
| CA\_25A-41C | CA\_25A-41A | 25 |  | |  | yes | | yes | yes | | yes | 60 | 0 |
| 41 | See CA\_41C Bandwidth Combination Set 1 in Table 5.6A.1-1 | | | | | | | | |
| CA\_25A-41D | CA\_25A-41A | 25 |  | |  | yes | | yes | yes | | yes | 80 | 0 |
| 41 | See CA\_41D Bandwidth Combination Set 0 in Table 5.6A.1-1 | | | | | | | | |
| CA\_25A-41E | CA\_25A-41A | 25 |  |  | | | yes | yes | | yes | yes | 100 | 0 |
| 41 | See CA\_41E Bandwidth Combination Set 0 in Table 5.6A.1-1 | | | | | | | | |
| CA\_25A-41F | CA\_25A-41A | 25 |  |  | | | yes | yes | | yes | yes | 120 | 0 |
| 41 | See CA\_41F Bandwidth Combination Set 0 in Table 5.6A.1-1 | | | | | | | | |

### 5.3.2 UE co-existence studies

Table 5.3.2-1 lists Band 25 + Band 41 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 5.3.2-1: Band x and Band y 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) | 840 – 581 | | | 4346 – 4605 | | |
| 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) | 1010 – 1334 | | | 3077 – 3530 | | |
| 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) | 6196 – 6520 | | | 6842 – 7295 | | |
| 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) | 1830 - 1935 | | | 2476 – 2710 | | |
| 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) | 2860 – 3249 | | | 5573 – 6220 | | |
| 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) | 1680 – 1162 | | | 8692 – 9210 | | |
| 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) | 8046 – 8435 | | | 9338 – 9985 | | |
| 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) | 8910 – 8069 | | | 5164 – 4710 | | |
| 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) | 4370 – 3658 | | | 753 – 170 | | |
| 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) | 11834 – 12675 | | | 9896 – 10350 | | |
| 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) | 11188 – 11900 | | | 10542 – 11125 | | |
| 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 5.3.2-1, 3rd order IMD may also fall into Rx frequencies of bands 25.

Table 5.3.2-2 summarizes frequency ranges where harmonics occur due to Band 25 and Band 41 CA.

**Table 5.3.2-2: Impact of UL/DL Harmonic**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **2nd Harmonic** | | **3rd Harmonic** | | **nth 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** |
| 25 | 1850 | 1915 | 1930 | 1995 | 3700 | 3830 | 3860 | 3990 |  |  |
| 41 | 2496 | 2690 | 2496 | 2690 | 4992 | 5380 | 4992 | 5380 |  |  |

It can be seen from Table 5.3.2-2 that there is no harmonic interference for CA\_25A-41E/F towards its own receive bands for this CA combination.

Table 5.3.2-3 lists the protected bands required for the 2UL bands CA configuration.

Table 5.3.2-3: Protected bands for the 2UL bands CA configuration

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| UL E-UTRA CA Configuration | Spurious emission | | | | | | |
| Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| CA\_25A-41A | E-UTRA Band 4, 5, 10, 12, 13, 14, 17, 24, 26, 27, 28, 29, 30, 42, 45, 48, 66, 70, 71 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 2, 25 |  | - |  | -50 | 1 | 2 |
| 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 channel bandwidth. | | | | | | | |

### 5.3.3 ∆TIB and ∆RIB values

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

Table 5.3.3-1: ΔTIB,c

| Inter-band CA Configuration | E-UTRA Band | ΔTIB,c [dB] |
| --- | --- | --- |
| CA\_25-41 | 25 | 0.5 |
| 41 | 0.41 |
| 0.92 |
| NOTE 1: The requirement is applied for UE transmitting on the frequency range of 2545-2690 MHz.  NOTE 2: The requirement is applied for UE transmitting on the frequency range of 2496-2545 MHz. | | |

Table 5.3.3-2: ΔRIB,c

| Inter-band CA Configuration | E-UTRA Band | ΔRIB,c [dB] |
| --- | --- | --- |
| CA\_25-41 | 41 | 01 |
| 0.52 |
| NOTE 1: The requirement is applied for UE transmitting on the frequency range of 2545-2690MHz.  NOTE 2: The requirement is applied for UE transmitting on the frequency range of 2496-2545MHz. | | |

### 5.3.4 REFSENS requirements

For these combinations, sensitivity degradation is allowed for a band if it is impacted by the UL of another band that is part of the same DC configuration due to cross band isolation issues. RAN4 studied the impact of cross band isolation between Band 25 and n41 for DC\_25A\_n41A and decided that the MSD would be [0.6] dB the B25 DL due to n41 UL, and no MSD for the n41 DL due to the B25 UL. The same analysis is applied to the LTE CA combinations between B25 and B41. Reference sensitivity is specified in Table 5.3.4-1 with uplink configuration specified in Table 5.3.4-2.

Table 5.3.4-1: Reference sensitivity due to cross band isolation

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| EUTRA CA Configuration | EUTRA band | Channel bandwidth | | | | | | Duplex mode | Applicable active UL band |
| 1.4 MHz (dBm) | 3 MHz (dBm) | 5 MHz (dBm) | 10 MHz (dBm) | 15 MHz (dBm) | 20 MHz (dBm) |
| CA\_25A-41A, CA\_25A-41C, CA\_25A-41D, CA\_25A-41E, CA\_25A-41F | 25 |  |  | [-95.9] | [-92.9] | [-91.1] | [-89.9] | FDD | 41 |

Table 5.3.4-2: Uplink configuration for reference sensitivity exceptions due to cross band isolation

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| UL band | DL band | 5 MHz | 10 MHz | 15 MHz | 20 MHz |
| 41 | 25 | 25 | 50 | 75 | 100 |

According to the co-existence analysis in table 5.3.2-1, the 3rd order IMD frequency range from “fx\_low – max BW fy” to “fx\_low + max BW fy” may fall into own Rx of band 25 in 1930 to 1935 MHz. However, when the UE is transmitting in 1910-1915 MHz, it will not be receiving in 1930-1935 MHz. Thus, no IMD issues are expected for this CA configuration with dual uplink carrier.

## 5.4 CA\_25A-25A-41A

### 5.4.1 Channel bandwidths per operating band

Table 5.4.1.-1: CA band combination of band 25 + 41

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| E-Utra 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 | | |
| 25 | 1850 MHz | – | 1915 MHz | 1930 MHz | – | 1995 MHz | FDD |
| 41 | 2496 MHz | – | 2690 MHz | 2496 MHz | – | 2690 MHz | TDD |

Table 5.4.1-2: E-UTRA CA configurations and bandwidth combination sets for UL CA\_25A-41A

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA configuration / Bandwidth combination set | | | | | | | | | | |
| E-UTRA CA Configuration | Uplink CA configurations | E-UTRA Bands | 1.4 MHz | 3 MHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | Maximum aggregated bandwidth  [MHz] | Bandwidth combination set |
| CA\_25A-25A-41A | CA\_25A-41A | 25 | See CA\_25A-25A Bandwidth Combination Set 1 in Table 5.6A.1-3 | | | | | | 60 | 0 |
| 41 |  |  | yes | yes | yes | yes |
| CA\_25A-25A-41C | CA\_25A-41A | 25 | See CA\_25A-25A Bandwidth Combination Set 1 in Table 5.6A.1-3 | | | | | | 80 | 0 |
| 41 | See CA\_41C Bandwidth Combination Set 1 in Table 5.6A.1-1 | | | | | |
| CA\_25A-25A-41D | CA\_25A-41A | 25 | See CA\_25A-25A Bandwidth Combination Set 1 in Table 5.6A.1-3 | | | | | | 100 | 0 |
| 41 | See CA\_41D bandwidth combination set 0 in table 5.6A.1-0 | | | | | |
| CA\_25A-25A-41E | CA\_25A-41A | 25 | See CA\_25A-25A Bandwidth Combination Set 1 in Table 5.6A.1-3 | | | | | | 120 | 0 |
| 41 | See CA\_41E bandwidth combination set 0 in table 5.6A.1-0 | | | | | |
| CA\_25A-25A-41F | CA\_25A-41A | 25 | See CA\_25A-25A Bandwidth Combination Set 1 in Table 5.6A.1-3 | | | | | | 140 | 0 |
| 41 | See CA\_41E bandwidth combination set 0 in table 5.6A.1-0 | | | | | |

### 5.4.2 UE co-existence studies

Table 5.4.2-1 lists Band 25 + Band 41 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 5.4.2-1: Band x and Band y 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) | 840 – 581 | | | 4346 – 4605 | | |
| 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) | 1010 – 1334 | | | 3077 – 3530 | | |
| 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) | 6196 – 6520 | | | 6842 – 7295 | | |
| 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) | 1830 - 1935 | | | 2476 – 2710 | | |
| 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) | 2860 – 3249 | | | 5573 – 6220 | | |
| 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) | 1680 – 1162 | | | 8692 – 9210 | | |
| 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) | 8046 – 8435 | | | 9338 – 9985 | | |
| 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) | 8910 – 8069 | | | 5164 – 4710 | | |
| 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) | 4370 – 3658 | | | 753 – 170 | | |
| 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) | 11834 – 12675 | | | 9896 – 10350 | | |
| 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) | 11188 – 11900 | | | 10542 – 11125 | | |
| 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 5.4.2-1, 3rd order IMD may also fall into Rx frequencies of bands 25.

Table 5.4.2-2 summarizes frequency ranges where harmonics occur due to Band 25 and Band 41 CA.

**Table 5.4.2-2: Impact of UL/DL Harmonic**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **2nd Harmonic** | | **3rd Harmonic** | | **nth 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** |
| 25 | 1850 | 1915 | 1930 | 1995 | 3700 | 3830 | 3860 | 3990 |  |  |
| 41 | 2496 | 2690 | 2496 | 2690 | 4992 | 5380 | 4992 | 5380 |  |  |

It can be seen from Table 5.4.2-1 that there is no harmonic interference for CA\_25A-41E/F towards its own receive bands for this CA combination.

Table 5.4.2-3 lists the protected bands required for the 2UL bands CA configuration.

Table 5.4.2-2: Protected bands for the 2UL bands CA configuration

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| UL E-UTRA CA Configuration | Spurious emission | | | | | | |
| Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| CA\_25A-41A | E-UTRA Band 4, 5, 10, 12, 13, 14, 17, 24, 26, 27, 28, 29, 30, 42, 45, 48, 66, 70, 71 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 2, 25 |  | - |  | -50 | 1 | 2 |
| 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 channel bandwidth. | | | | | | | |

### 5.4.3∆TIB and ∆RIB values

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

Table 5.4.3-1: ΔTIB,c

| Inter-band CA Configuration | E-UTRA Band | ΔTIB,c [dB] |
| --- | --- | --- |
| CA\_25-41 | 25 | 0.5 |
| 41 | 0.41 |
| 0.92 |
| NOTE 1: The requirement is applied for UE transmitting on the frequency range of 2545-2690 MHz.  NOTE 2: The requirement is applied for UE transmitting on the frequency range of 2496-2545 MHz. | | |

Table 5.4.3-2: ΔRIB,c

| Inter-band CA Configuration | E-UTRA Band | ΔRIB,c [dB] |
| --- | --- | --- |
| CA\_25-41 | 41 | 01 |
| 0.52 |
| NOTE 1: The requirement is applied for UE transmitting on the frequency range of 2545-2690MHz.  NOTE 2: The requirement is applied for UE transmitting on the frequency range of 2496-2545MHz. | | |

### 5.4.4 REFSENS requirements

For these combinations, sensitivity degradation is allowed for a band if it is impacted by the UL of another band that is part of the same DC configuration due to cross band isolation issues. RAN4 studied the impact of cross band isolation between Band 25 and n41 for DC\_25A\_n41A and decided that the MSD would be [0.6] dB the B25 DL due to n41 UL, and no MSD for the n41 DL due to the B25 UL. The same analysis is applied to the LTE CA combinations between B25 and B41. Reference sensitivity is specified in Table 5.4.4-1 with uplink configuration specified in Table 5.4.4-2.

Table 5.4.4-1: Reference sensitivity due to cross band isolation

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| EUTRA CA Configuration | EUTRA band | Channel bandwidth | | | | | | Duplex mode | Applicable active UL band |
| 1.4 MHz (dBm) | 3 MHz (dBm) | 5 MHz (dBm) | 10 MHz (dBm) | 15 MHz (dBm) | 20 MHz (dBm) |
| CA\_25A-25A-41A, CA\_25A-25A-41C, CA\_25A-25A-41D, CA\_25A-25A-41E, CA\_25A-25A-41F | 25 |  |  | [-95.9] | [-92.9] | [-91.1] | [-89.9] | FDD | 41 |

Table 5.4.4-2: Uplink configuration for reference sensitivity exceptions due to cross band isolation

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| UL band | DL band | 5 MHz | 10 MHz | 15 MHz | 20 MHz |
| 41 | 25 | 25 | 50 | 75 | 100 |

According to the co-existence analysis in table 5.4.2-1, the 3rd order IMD frequency range from “fx\_low – max BW fy” to “fx\_low + max BW fy” may fall into own Rx of band 25 in 1930 to 1935 MHz. However, when the UE is transmitting in 1910-1915 MHz, it will not be receiving in 1930-1935 MHz. Thus, no IMD issues are expected for this CA configuration with dual uplink carrier.

## 5.5 CA\_25A-26A

### 5.5.1 Channel bandwidths per operating band

Table 5.5.1.-1: CA band combination of band 25 + 26

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| E-Utra 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 | | |
| 25 | 1850 MHz | – | 1915 MHz | 1930 MHz | – | 1995 MHz | FDD |
| 26 | 814 MHz | – | 849 MHz | 859 MHz | – | 894 MHz | FDD |

Table 5.5.1-2: E-UTRA CA configurations and bandwidth combination sets for UL CA\_25A-26A

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA configuration / Bandwidth combination set | | | | | | | | | | |
| E-UTRA CA Configuration | Uplink CA configurations | E-UTRA Bands | 1.4 MHz | 3 MHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | Maximum aggregated bandwidth  [MHz] | Bandwidth combination set |
| CA\_25A-26A | CA\_25A-26A | 25 |  | yes | yes | yes | yes | yes | 35 | 0 |
| 26 | yes | yes | yes | yes | yes |  |

### 5.5.2 UE co-existence studies

No coexistence issues are present with this CA combination.

Table 5.5.2-2 lists the protected bands required for the 2UL bands CA configuration.

Table 5.5.2-2: Protected bands for the 2UL bands CA configuration

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| UL E-UTRA CA Configuration | Spurious emission | | | | | | |
| Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| CA\_25A-26A | E-UTRA Band 4, 5, 10,12, 13, 14, 17, 24, 26, 29, 30, 42, 48, 53, 66, 70, 71, 85 | FDL\_low | - | FDL\_high | -50 | 1 |  |

### 5.5.3∆TIB and ∆RIB values

For 2UL CA\_25-26, the same requirements on values for ∆TIB,c and ∆RIB,c  of 1UL CA\_25-26 can be applied. Therefore, for two simultaneous UL, the ΔTIB,c and ΔRIB,c values are shown in table 5.5.3-1 and in table 5.5.3-2.

Table 5.5.3-1: IB,c

| Inter-band CA Configuration | E-UTRA Band | ΔTIB,c [dB] |
| --- | --- | --- |
| CA\_25-26 | 25 | 0.3 |
| 26 | 0.3 |

Table 5.5.3-2: R IB,c

| Inter-band CA Configuration | E-UTRA Band | ΔRIB,c [dB] |
| --- | --- | --- |
| CA\_25-26 | 25 | 0 |
| 26 | 0 |

### 5.5.4 REFSENS requirements

No additional REFSENS exceptions are required for this CA combination

## 5.6 CA\_25A-25A-26A

### 5.6.1 Channel bandwidths per operating band

Table 5.6.1.-1: CA band combination of band 25 + 26

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| E-Utra 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 | | |
| 25 | 1850 MHz | – | 1915 MHz | 1930 MHz | – | 1995 MHz | FDD |
| 26 | 814 MHz | – | 849 MHz | 859 MHz | – | 894 MHz | FDD |

Table 5.6.1-2: E-UTRA CA configurations and bandwidth combination sets for UL CA\_25A-26A

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA configuration / Bandwidth combination set | | | | | | | | | | | |
| E-UTRA CA Configuration | Uplink CA configurations | E-UTRA Bands | 1.4 MHz | 3 MHz | 5 MHz | 10 MHz | | 15 MHz | 20 MHz | Maximum aggregated bandwidth  [MHz] | Bandwidth combination set |
| CA\_25A-25A-26A | CA\_25A-26A | 25 | See CA\_25A-25A Bandwidth Combination Set 1 in Table 5.6A.1-3 | | | | | | | 45 | 0 |
| 26 |  | yes | yes | |  |  |  |

### 5.6.2 UE co-existence studies

No coexistence issues are present with this CA combination.

Table 5.6.2-2 lists the protected bands required for the 2UL bands CA configuration.

Table 5.6.2-2: Protected bands for the 2UL bands CA configuration

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| UL E-UTRA CA Configuration | Spurious emission | | | | | | |
| Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| CA\_25A-25A-26A | E-UTRA Band 4, 5, 10,12, 13, 14, 17, 24, 26, 29, 30, 42, 48, 53, 66, 70, 71, 85 | FDL\_low | - | FDL\_high | -50 | 1 |  |

### 5.6.3∆TIB and ∆RIB values

For 2UL CA\_25-25-26, the same requirements on values for ∆TIB,c and ∆RIB,c  of 1UL CA\_25-26-26 can be applied. Therefore, for two simultaneous UL, the ΔTIB,c and ΔRIB,c values are shown in table 5.6.3-1 and in table 5.6.3-2.

Table 5.6.3-1: IB,c

| Inter-band CA Configuration | E-UTRA Band | ΔTIB,c [dB] |
| --- | --- | --- |
| CA\_25-25-26 | 25 | 0.3 |
| 26 | 0.3 |

Table 5.6.3-2: R IB,c

| Inter-band CA Configuration | E-UTRA Band | ΔRIB,c [dB] |
| --- | --- | --- |
| CA\_25-25-26 | 25 | 0 |
| 26 | 0 |

### 5.6.4 REFSENS requirements

No additional REFSENS exceptions are expected for this CA combination

## 5.7 DL\_48A-66A\_UL\_48A-66A\_BCS0

### 5.7.1 Channel bandwidths per operating band for CA

Table 5.7.1-1: Supported E-UTRA bandwidths per CA configuration for inter-band CA

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA configuration / Bandwidth combination set | | | | | | | | | | |
| E-UTRA CA Configuration | Uplink CA configurations | E-UTRA Bands | 1.4 MHz | 3 MHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | Maximum aggregated bandwidth  [MHz] | Bandwidth combination set |
| CA\_48A-66A | CA\_48A-66A | 48 |  |  | Yes | Yes | Yes | Yes | 40 | 0 |
| 66 |  |  | Yes | Yes | Yes | Yes |

### 5.7.2 ΔTIB,c and ΔRIB,c values

Same ΔTIB,c and ΔRIB,c values as in TR 36.715-02-02 [2] for DL\_48A-66A\_UL\_ 48A-66A\_BCS0.

Table 5.7.2-1: ΔTIB,c

|  |  |  |
| --- | --- | --- |
| Inter-band CA Configuration | E-UTRA Band | ΔTIB,c [dB] |
| CA\_48A-66A | 48 | 0.8 |
| 66 | 0.6 |

Table 5.7.2-2: ΔRIB,c

|  |  |  |
| --- | --- | --- |
| Inter-band CA Configuration | E-UTRA Band | ΔRIB,c [dB] |
| CA\_48A-66A | 48 | 0.5 |
| 66 | 0.2 |

### 5.7.2 UE co-existence studies

Table 5.7.2-1 lists Band 48 + Band 66 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 5.7.2-1: Band x and Band y UL IMD products

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| UE UL carriers | fx\_low | fx\_high | fy\_low | fy\_high |
| 2nd order IMD products | |fy\_high – fx\_low| | |fy\_low – fx\_high| | |fy\_low + fx\_low| | |fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 1990 | 1770 | 5260 | 5480 |
| 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) | 280 | 10 | 5320 | 5690 |
| 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) | 6970 | 7260 | 8810 | 9180 |
| 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) | 3980 | 3540 | 10520 | 10960 |
| 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) | 1430 | 1790 | 8870 | 9390 |
| 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) | 8680 | 9040 | 12360 | 12880 |
| 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) | 13090 | 12420 | 3570 | 3140 |
| 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) | 15910 | 16580 | 10390 | 10820 |
| 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) | 7680 | 7090 | 1760 | 2270 |
| 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) | 14070 | 14660 | 12230 | 12740 |

Based on Table 5.7.2-1, 5th order IMD may also fall into Rx frequencies of bands 66 as well as that 4th and 5th order IMD may fall into Rx frequencies of band 48.

Table 5.7.2-2 summarizes frequency ranges where harmonics occur due to Band 48 and Band 66 CA.

**Table 5.7.2-2: Impact of UL/DL Harmonic**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | **2nd Harmonic** | | **3rd Harmonic** | | **4th Harmonic** | | **5th Harmonic** | |
| **Band** | **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** | **UL Low Band Edge** | **UL High Band Edge** |
| 48 | 3550 | 3700 | 7100 | 7400 | 10650 | 11100 | 14200 | 14800 | 17750 | 18500 |
| 66 | 1710 | 1780 | 3420 | 3560 | 5130 | 5340 | 6840 | 7120 | 8550 | 8900 |

It can be seen from Table 5.7.2-2 that there is harmonic interference for band 2 UL towards its own receive band 48.

Table 5.7.2-3 lists the protected bands required for the 2UL bands CA configuration.

## 5.8 DL\_2A-48A\_UL\_2A-48A\_BCS0 DL\_2A-48A-48A\_UL\_2A-48A\_BCS0 DL\_2A-48A-48C\_UL\_2A-48A\_BCS0 DL\_2A-48C\_UL\_2A-48A\_BCS0 DL\_2A-48D\_UL\_2A-48A\_BCS0 DL\_2A-48A-48D\_UL\_2A-48A\_BCS0 DL\_2A-48E\_UL\_2A-48A\_BCS0 DL\_2A-48A-48E\_UL\_2A-48A\_BCS0

### 5.8.1 Channel bandwidths per operating band for CA

Table 5.8.1-1: Supported E-UTRA bandwidths per CA configuration for inter-band CA

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA configuration / Bandwidth combination set | | | | | | | | | | |
| E-UTRA CA Configuration | Uplink CA configurations | E-UTRA Bands | 1.4 MHz | 3 MHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | Maximum aggregated bandwidth  [MHz] | Bandwidth combination set |
| CA\_2A-48A | CA\_2A-48A | 2 |  |  | Yes | Yes | Yes | Yes | 40 | 0 |
| 48 |  |  | Yes | Yes | Yes | Yes |
| CA\_2A-48A-48A | CA\_2A-48A | 2 |  |  | Yes | Yes | Yes | Yes | 60 | 0 |
| 48 | See CA\_48A-48A Bandwidth combination set 0 in Table 5.6A.1-3 of [1] | | | | | |
| CA\_2A-48C | CA\_2A-48A | 2 |  |  | Yes | Yes | Yes | Yes | 60 | 0 |
| 48 | See CA\_48C Bandwidth combination set 0 in Table 5.6A.1-1 of [1] | | | | | |
| CA\_2A-48D | CA\_2A-48A | 2 |  |  | Yes | Yes | Yes | Yes | 80 | 0 |
| 48 | See CA\_48D Bandwidth combination set 0 in Table 5.6A.1-3 of [1] | | | | | |
| CA\_2A-48A-48C | CA\_2A-48A | 2 |  |  | Yes | Yes | Yes | Yes | 80 | 0 |
| 48 | See the CA\_48A-48C Bandwidth combination set 0 in the Table 5.6A.1-3 of [1] | | | | | |
| CA\_2A-48E | CA\_2A-48A | 2 |  |  | Yes | Yes | Yes | Yes | 100 | 0 |
| 48 | See CA\_48E Bandwidth Combination Set 0 in Table 5.6A.1-1 of [1] | | | | | |
| CA\_2A-48A-48D | CA\_2A-48A | 2 |  |  | Yes | Yes | Yes | Yes | 100 | 0 |
| 48 |  |  | Yes | Yes | Yes | Yes |
| CA\_2A-48A-48E | CA\_2A-48A | 2 |  |  | Yes | Yes | Yes | Yes | 120 | 0 |
| 48 | See the CA\_48A-46E Bandwidth combination set 0 in Table 5.6A.1-3 of [1] | | | | | |

### 5.8.2 ΔTIB,c and ΔRIB,c values

Same ΔTIB,c and ΔRIB,c values as in TR 36.715-02-02 [2] for DL\_2A-48A\_UL\_ 2A-48A\_BCS0.

Table 5.8.2-1: ΔTIB,c

|  |  |  |
| --- | --- | --- |
| Inter-band CA Configuration | E-UTRA Band | ΔTIB,c [dB] |
| CA\_2A-48A | 2 | 0.6 |
| 48 | 0.8 |

Table 5.8.2-2: ΔRIB,c

|  |  |  |
| --- | --- | --- |
| Inter-band CA Configuration | E-UTRA Band | ΔRIB,c [dB] |
| CA\_2A-48A | 2 | 0.2 |
| 48 | 0.5 |

### 5.8.2 UE co-existence studies

Table 5.8.2-1 lists Band 2 + Band 48 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 5.8.2-1: Band x and Band y UL IMD products

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| UE UL carriers | fx\_low | fx\_high | fy\_low | fy\_high |
| 2nd order IMD products | |fy\_high – fx\_low| | |fy\_low – fx\_high| | |fy\_low + fx\_low| | |fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 1850 | 1640 | 5400 | 5610 |
| 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) | 0 | 270 | 5190 | 5550 |
| 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) | 7250 | 7520 | 8950 | 9310 |
| 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) | 3700 | 3280 | 10800 | 11220 |
| 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) | 1850 | 2180 | 8740 | 9250 |
| 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) | 9100 | 9430 | 12500 | 13010 |
| 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) | 12950 | 12290 | 4090 | 3700 |
| 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) | 16050 | 16710 | 10950 | 11340 |
| 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) | 7400 | 6830 | 1370 | 1850 |
| 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) | 14350 | 14920 | 12650 | 13130 |

Based on Table 5.8.2-1, 4th order IMD may also fall into Rx frequencies of bands 2 as well as that 4th and 5th order IMD may fall into Rx frequencies of band 48.

Table 5.8.2-2 summarizes frequency ranges where harmonics occur due to Band 2 and Band 48 CA.

**Table 5.8.2-2: Impact of UL/DL Harmonic**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | **2nd Harmonic** | | **3rd Harmonic** | | **4th Harmonic** | | **5th Harmonic** | |
| **Band** | **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** | **UL Low Band Edge** | **UL High Band Edge** |
| 2 | 1850 | 1910 | 3700 | 3820 | 5550 | 5730 | 7400 | 7640 | 9250 | 9550 |
| 48 | 3550 | 3700 | 7100 | 7400 | 10650 | 11100 | 14200 | 14800 | 17750 | 18500 |

It can be seen from Table 5.8.2-2 that there is harmonic interference for band 2 UL towards its own receive band 48.

Table 5.8.2-3 lists the protected bands required for the 2UL bands CA configuration.

Table 5.8.2-3: Protected bands for the 2UL bands CA configuration

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| UL E-UTRA CA Configuration | Spurious emission | | | | | | |
| Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| CA\_2A-48A | E-UTRA Band 4, 5, 12, 13, 14, 17, 24, 25, 26, 29, 30, 41, 50, 51, 53, 66, 70, 71, 74, 85 | FDL\_low | - | FDL\_high | -50 | 1 |  |

### 5.8.4 REFSENS requirements

As can be seen in 5.8.2 there is MSD needed for IMD4 falling into band 2. These need to be covered in TS 36.101 as in table below. MSD value are same as for CA\_2A-49A.

Table 7.3.1A-0f: 2DL/2UL interband Reference sensitivity QPSK PREFSENS and uplink/downlink configurations

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA Band / Channel bandwidth / NRB / Duplex mode | | | | | | | | Source of IMD |
| EUTRA CA  Configuration | EUTRA band | UL Fc  (MHz) | UL/DL BW  (MHz) | UL  CLRB | DL Fc (MHz) | MSD  (dB) | Duplex mode |
| CA\_2A-48A | 2 | 1852.5 | 5 | 25 | 1932.5 | [12] | FDD | IMD4 |
| 48 | 3625 | 20 | 100 | 3625 | N/A | TDD | N/A |

As also can be seen in 5.8.2 there is MSD needed for band 2 2nd harmonics falling into band 48 which are already covered in TS 36.101 Table 7.3.1A-0a and Table 7.3.1A-0b. However, Table 7.3.1A-0a and Table 7.3.1A-0b also need to include the new DL configurations added: CA\_2A-48A-48D, CA\_2A-48E and CA\_2A-48A-48E.

## 5.9 CA\_2-14

### 5.9.1 Channel bandwidths per operating band for CA

Table 5.9.1-1: Inter-band CA operating bands

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| E‑UTRA Operating Band | Uplink (UL) operating band BS receive UE transmit | | | Downlink (DL) operating band BS transmit  UE receive | | | Duplex Mode |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | |
| 2 | 1850 MHz | – | 1910 MHz | 1930 MHz | – | 1990 MHz | FDD |
| 14 | 788 MHz | – | 798 MHz | 758 MHz | – | 768 MHz | TDD |

Table 5.9.1-2: Supported E-UTRA bandwidths per CA configuration for inter-band CA

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA configuration / Bandwidth combination set | | | | | | | | | | |
| E-UTRA CA Configuration | Uplink CA configurations | E-UTRA Bands | 1.4 MHz | 3 MHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | Maximum aggregated bandwidth  [MHz] | Bandwidth combination set |
| CA\_2A-14A | CA\_2A-14A | 2 |  |  | Yes | Yes | Yes | Yes | 30 | 0 |
| 14 |  |  | Yes | Yes |  |  |

### 5.9.2 Co-existence studies

The following table shows the 2 UL harmonics and IMD products of band 2 and band 14.

**Table 5.9.2-1: CA\_2A-14A UL harmonics and IMD products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| UE UL carriers | f1\_low | f1\_high | f2\_low | f2\_high |
| UL frequencies (MHz) | 788 | 798 | 1850 | 1910 |
| 2nd harmonic | 2\* f1\_low | 2\*f1\_high | 2\*f2\_low | 2\*f2\_high |
| harmonic frequency limit (MHz) | 1576 | 1596 | 3700 | 3820 |
| 3rd harmonic | 3\* f1\_low | 3\*f1\_high | 3\*f2\_low | 3\*f2\_high |
| harmonic frequency limit (MHz) | 2364 | 2394 | 5550 | 5730 |
| 2nd order IMD products | f2\_low – f1\_high | f2\_high – f1\_low | f2\_low + f1\_low | f2\_high + f1\_high |
| IMD frequency limit (MHz) | 1052 | 1122 | 2638 | 2708 |
| 3rd order IMD products | 2\*f1\_low – f2\_high | 2\*f1\_high – f2\_low | 2\*f2\_low – f1\_high | 2\*f2\_high – f1\_low |
| IMD frequency limit (MHz) | -334 | -254 | 2902 | 3032 |
| 3rd order IMD products | 2\*f1\_low + f2\_low | 2\*f1\_high + f2\_high | 2\*f2\_low + f1\_low | 2\*f2\_high + f1\_high |
| IMD frequency limit (MHz) | 3426 | 3506 | 4488 | 4618 |
| 4th order IMD products | 3\*f1\_low – f2\_high | 3\*f1\_high – f2\_low | 3\*f2\_low – f1\_high | 3\*f2\_high – f1\_low |
| IMD frequency limit (MHz) | 454 | 544 | 4752 | 4942 |
| 4th order IMD products | 3\*f1\_low + f2\_low | 3\*f1\_high + f2\_high | 3\*f2\_low + f1\_low | 3\*f2\_high + f1\_high |
| IMD frequency limit (MHz) | 4214 | 4304 | 6338 | 6528 |
| 4th order IMD products | 2\*f1\_low – 2\*f2\_high | 2\*f1\_high – 2\*f2\_low | 2\*f1\_low + 2\*f2\_low | 2\*f1\_high + 2\*f2\_high |
| IMD frequency limit (MHz) | -2244 | -2104 | 5276 | 5416 |
| 5th order IMD products | f1\_low – 4\*f2\_high | f1\_high – 4\*f2\_low | f2\_low – 4\*f1\_high | f2\_high – 4\*f1\_low |
| IMD frequency limit (MHz) | -6852 | -6602 | -1342 | -1242 |
| 5th order IMD products | f1\_low + 4\*f2\_low | f1\_high + 4\*f2\_high | f2\_low + 4\*f1\_low | f2\_high + 4\*f1\_high |
| IMD frequency limit (MHz) | 8188 | 8438 | 5002 | 5102 |
| 5th order IMD products | 2\*f1\_low – 3\*f2\_high | 2\*f1\_high - 3\*f2\_low | 2\*f2\_low – 3\*f1\_high | 2\*f2\_high – 3\*f1\_low |
| IMD frequency limit (MHz) | -4154 | -3954 | 1306 | 1456 |
| 5th order IMD products | 2\*f1\_low + 3\*f2\_low | 2\*f1\_high + 3\*f2\_high | 2\*f2\_low + 3\*f1\_low | 2\*f2\_high + 3\*f1\_high |
| IMD frequency limit (MHz) | 7126 | 7326 | 6064 | 6214 |

Table 5.9.2-1 concludes that no harmonic or IMD product up to 5th order falls into UE’s own DL bands.

The spurious emission towards UE coexisting bands are specified for Regions 3 according to band 2 and band 14 coexisting bands.

Table 5.9.2-2: Requirements for uplink inter-band carrier aggregation CA\_2-14

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA Configuration | Spurious emission | | | | | | |
| Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| CA\_2-14 | E-UTRA Band 4, 5, 10, 12, 13, 14, 17, 24, 26, 27, 29, 30, 41, 48, 53, 66, 70, 71, 85 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 2, 25 | FDL\_low | - | FDL\_high | -50 | 1 | 3 |
| Frequency range | 769 | - | 775 | -35 | 0.00625 | 3 |
| Frequency range | 799 | - | 805 | -35 | 0.00625 | 3, 9 |
| NOTE 3: 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 9: Whether the applicable frequency range should be 793-805MHz instead of 799-805MHz is TBD. | | | | | | | |

### 5.9.3 ∆TIB and ∆RIB values

The ΔTIB,c and ΔRIB,c values for two band CA\_2-14 are already specified in TS 36.101 Table 6.2.5-2 (two bands) for ΔTIB,c and Table 7.3.1-1A (two bands) for ΔRIB,c.

### 5.9.4 REFSENS requirements

Since there is no harmonic or IMD relation, no MSD is required due to harmonic or IMD.

Table 5.x.2-3: Protected bands for the 2UL bands CA configuration

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| UL E-UTRA CA Configuration | Spurious emission | | | | | | |
| Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| CA\_48A-66A | E-UTRA Band 2, 4, 5, 7, 10, 12, 13, 14, 17, 24, 25, 26, 27, 28, 29, 30, 41, 43, 48, 50, 51, 53, 66, 70, 71, 74, 85 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 42 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| NOTE 2: 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. 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, 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. | | | | | | | |

### 5.9.4 REFSENS requirements

As can be seen in 5.9.2 there is MSD needed for IMD5 falling into band 66. These need to be covered in TS 36.101 as in table below. MSD value derived from other used IMD5 MSD values in Table 7.3.1A-0f.

Table 7.3.1A-0f: 2DL/2UL interband Reference sensitivity QPSK PREFSENS and uplink/downlink configurations

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA Band / Channel bandwidth / NRB / Duplex mode | | | | | | | | Source of IMD |
| EUTRA CA  Configuration | EUTRA band | UL Fc  (MHz) | UL/DL BW  (MHz) | UL  CLRB | DL Fc (MHz) | MSD  (dB) | Duplex mode |
| CA\_48A-66A | 48 | 3660 | 5 | 25 | 3660 | N/A | TDD | N/A |
| 66 | 1730 | 5 | 25 | 2130 | 5.0 | FDD | IMD5 |

As also can be seen in 5.9.2 there is MSD needed for band 66 2nd harmonics falling into band 48 which are already covered in TS 36.101 Table 7.3.1A-0a and Table 7.3.1A-0b.

## 5.10 CA\_4-28

### 5.10.1 Channel bandwidths per operating band for CA

Table 5.10.1-1: Inter-band CA operating bands

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| E‑UTRA Operating Band | Uplink (UL) operating band BS receive UE transmit | | | Downlink (DL) operating band BS transmit  UE receive | | | Duplex Mode |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | |
| 4 | 1710 MHz | – | 1755 MHz | 2110 MHz | – | 2155 MHz | FDD |
| 28 | 703 MHz | – | 748 MHz | 758 MHz | – | 803 MHz | FDD |

Table 5.10.1-2: Supported E-UTRA bandwidths per CA configuration for inter-band CA

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA configuration / Bandwidth combination set | | | | | | | | | | |
| E-UTRA CA Configuration | Uplink CA configurations | E-UTRA Bands | 1.4 MHz | 3 MHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | Maximum aggregated bandwidth  [MHz] | Bandwidth combination set |
| CA\_4A-28A | CA\_4A-28A | 4 |  |  | Yes | Yes | Yes | Yes | 40 | 0 |
| 28 |  |  | Yes | Yes | Yes | Yes |

### 5.10.2 Co-existence studies

The following table shows the 2 UL harmonics and IMD products of band 4 and band 28.

**Table 5.10.2-1: CA\_4A-28A UL harmonics and IMD products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| UE UL carriers | f1\_low | f1\_high | f2\_low | f2\_high |
| UL frequencies (MHz) | 703 | 748 | 1710 | 1755 |
| 2nd harmonic | 2\* f1\_low | 2\*f1\_high | 2\*f2\_low | 2\*f2\_high |
| harmonic frequency limit (MHz) | 1406 | 1496 | 3420 | 3510 |
| 3rd harmonic | 3\* f1\_low | 3\*f1\_high | 3\*f2\_low | 3\*f2\_high |
| harmonic frequency limit (MHz) | 2109 | 2244 | 5130 | 5265 |
| 2nd order IMD products | f2\_low – f1\_high | f2\_high – f1\_low | f2\_low + f1\_low | f2\_high + f1\_high |
| IMD frequency limit (MHz) | 962 | 1052 | 2413 | 2503 |
| 3rd order IMD products | 2\*f1\_low – f2\_high | 2\*f1\_high – f2\_low | 2\*f2\_low – f1\_high | 2\*f2\_high – f1\_low |
| IMD frequency limit (MHz) | -349 | -214 | 2672 | 2807 |
| 3rd order IMD products | 2\*f1\_low + f2\_low | 2\*f1\_high + f2\_high | 2\*f2\_low + f1\_low | 2\*f2\_high + f1\_high |
| IMD frequency limit (MHz) | 3116 | 3251 | 4123 | 4258 |
| 4th order IMD products | 3\*f1\_low – f2\_high | 3\*f1\_high – f2\_low | 3\*f2\_low – f1\_high | 3\*f2\_high – f1\_low |
| IMD frequency limit (MHz) | 354 | 534 | 4382 | 4562 |
| 4th order IMD products | 3\*f1\_low + f2\_low | 3\*f1\_high + f2\_high | 3\*f2\_low + f1\_low | 3\*f2\_high + f1\_high |
| IMD frequency limit (MHz) | 3819 | 3999 | 5833 | 6013 |
| 4th order IMD products | 2\*f1\_low – 2\*f2\_high | 2\*f1\_high – 2\*f2\_low | 2\*f1\_low + 2\*f2\_low | 2\*f1\_high + 2\*f2\_high |
| IMD frequency limit (MHz) | -2104 | -1924 | 4826 | 5006 |
| 5th order IMD products | f1\_low – 4\*f2\_high | f1\_high – 4\*f2\_low | f2\_low – 4\*f1\_high | f2\_high – 4\*f1\_low |
| IMD frequency limit (MHz) | -6317 | -6092 | -1282 | -1057 |
| 5th order IMD products | f1\_low + 4\*f2\_low | f1\_high + 4\*f2\_high | f2\_low + 4\*f1\_low | f2\_high + 4\*f1\_high |
| IMD frequency limit (MHz) | 7543 | 7768 | 4522 | 4747 |
| 5th order IMD products | 2\*f1\_low – 3\*f2\_high | 2\*f1\_high - 3\*f2\_low | 2\*f2\_low – 3\*f1\_high | 2\*f2\_high – 3\*f1\_low |
| IMD frequency limit (MHz) | -3859 | -3634 | 1176 | 1401 |
| 5th order IMD products | 2\*f1\_low + 3\*f2\_low | 2\*f1\_high + 3\*f2\_high | 2\*f2\_low + 3\*f1\_low | 2\*f2\_high + 3\*f1\_high |
| IMD frequency limit (MHz) | 6536 | 6761 | 5529 | 5754 |

Table 5.10.2-1 concludes that no IMD product up to 5th order falls into UE’s own DL bands. The 3rd harmonic of band 28 UL falls into band 4 DL.

The spurious emission towards UE coexisting bands are specified for Regions 3 according to band 4 and band 28 coexisting bands.

Table 5.10.2-2: Requirements for uplink inter-band carrier aggregation CA\_4-28

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA Configuration | Spurious emission | | | | | | |
| Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| CA\_4-28 | E-UTRA Band 2, 5, 7, 12, 13, 14, 17, 24, 25, 26, 27, 28, 29, 30, 41, 48, 53, 70, 71, 85 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 4, 10, 42, 43, 50, 51, 66, 74 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| Frequency range | 470 | - | 710 | -26.2 | 6 | 23 |
| Frequency range | 758 |  | 773 | -32 | 1 | 3 |
| Frequency range | 773 |  | 803 | -50 | 1 |  |
| NOTE 2: 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. 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: 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 23: This requirement is applicable for 5 and 10 MHz E-UTRA channel bandwidth allocated within 718-728MHz. For carriers of 10 MHz bandwidth, this requirement applies for an uplink transmission bandwidth less than or equal to 30 RB with RBstart > 1 and RBstart<48. | | | | | | | |

### 5.10.3 ∆TIB and ∆RIB values

The ΔTIB,c and ΔRIB,c values for two band CA\_4-28 are already specified in TS 36.101 Table 6.2.5-2 (two bands) for ΔTIB,c and Table 7.3.1-1A (two bands) for ΔRIB,c.

### 5.10.4 REFSENS requirements

Since there is no IMD relation, no MSD is required due to IMD. MSD due to single uplink harmonic is already specified in 7.3.1A of TS 36.101 for CA\_4A-28A.

## 5.11 CA\_13-66

### 5.11.1 Channel bandwidths per operating band for CA

Table 5.11.1-1: Inter-band CA operating bands

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| E‑UTRA Operating Band | Uplink (UL) operating band BS receive UE transmit | | | Downlink (DL) operating band BS transmit  UE receive | | | Duplex Mode |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | |
| 13 | 777 MHz | – | 787 MHz | 746 MHz | – | 756 MHz | FDD |
| 66 | 1710 MHz | – | 1780 MHz | 2110 MHz | – | 2200 MHz | FDD |

Table 5.11.1-2: Supported E-UTRA bandwidths per CA configuration for inter-band CA

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA configuration / Bandwidth combination set | | | | | | | | | | |
| E-UTRA CA Configuration | Uplink CA configurations | E-UTRA Bands | 1.4 MHz | 3 MHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | Maximum aggregated bandwidth  [MHz] | Bandwidth combination set |
| CA\_13A-66A | CA\_13A-66A | 13 |  |  | Yes | Yes |  |  | 30 | 0 |
| 66 |  |  | Yes | Yes | Yes | Yes |
| CA\_13A-66A-66A | CA\_13A-66A | 13 |  |  | Yes | Yes |  |  | 50 | 0 |
| 66 | See CA\_66A-66A Bandwidth combination set 0 in Table 5.6A.1-3 | | | | | |
| CA\_13A-66B | CA\_13A-66A | 13 |  |  | Yes | Yes |  |  | 30 | 0 |
| 66 | See CA\_66B Bandwidth combination set 0 in Table 5.6A.1-1 | | | | | |
| CA\_13A-66C | CA\_13A-66A | 13 |  |  | Yes | Yes |  |  | 70 | 0 |
| 66 | See CA\_66C Bandwidth combination set 0 in Table 5.6A.1-1 | | | | | |

### 5.11.2 Co-existence studies

The following table shows the 2 UL harmonics and IMD products of band 13 and band 66.

**Table 5.11.2-1: CA\_13A-66A UL harmonics and IMD products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| UE UL carriers | f1\_low | f1\_high | f2\_low | f2\_high |
| UL frequencies (MHz) | 777 | 787 | 1710 | 1780 |
| 2nd harmonic | 2\* f1\_low | 2\*f1\_high | 2\*f2\_low | 2\*f2\_high |
| harmonic frequency limit (MHz) | 1554 | 1574 | 3420 | 3560 |
| 3rd harmonic | 3\* f1\_low | 3\*f1\_high | 3\*f2\_low | 3\*f2\_high |
| harmonic frequency limit (MHz) | 2331 | 2361 | 5130 | 5340 |
| 2nd order IMD products | f2\_low – f1\_high | f2\_high – f1\_low | f2\_low + f1\_low | f2\_high + f1\_high |
| IMD frequency limit (MHz) | 923 | 1003 | 2487 | 2567 |
| 3rd order IMD products | 2\*f1\_low – f2\_high | 2\*f1\_high – f2\_low | 2\*f2\_low – f1\_high | 2\*f2\_high – f1\_low |
| IMD frequency limit (MHz) | -226 | -136 | 2633 | 2783 |
| 3rd order IMD products | 2\*f1\_low + f2\_low | 2\*f1\_high + f2\_high | 2\*f2\_low + f1\_low | 2\*f2\_high + f1\_high |
| IMD frequency limit (MHz) | 3264 | 3354 | 4197 | 4347 |
| 4th order IMD products | 3\*f1\_low – f2\_high | 3\*f1\_high – f2\_low | 3\*f2\_low – f1\_high | 3\*f2\_high – f1\_low |
| IMD frequency limit (MHz) | 551 | 651 | 4343 | 4563 |
| 4th order IMD products | 3\*f1\_low + f2\_low | 3\*f1\_high + f2\_high | 3\*f2\_low + f1\_low | 3\*f2\_high + f1\_high |
| IMD frequency limit (MHz) | 4041 | 4141 | 5907 | 6127 |
| 4th order IMD products | 2\*f1\_low – 2\*f2\_high | 2\*f1\_high – 2\*f2\_low | 2\*f1\_low + 2\*f2\_low | 2\*f1\_high + 2\*f2\_high |
| IMD frequency limit (MHz) | -2006 | -1846 | 4974 | 5134 |
| 5th order IMD products | f1\_low – 4\*f2\_high | f1\_high – 4\*f2\_low | f2\_low – 4\*f1\_high | f2\_high – 4\*f1\_low |
| IMD frequency limit (MHz) | -6343 | -6053 | -1438 | -1328 |
| 5th order IMD products | f1\_low + 4\*f2\_low | f1\_high + 4\*f2\_high | f2\_low + 4\*f1\_low | f2\_high + 4\*f1\_high |
| IMD frequency limit (MHz) | 7617 | 7907 | 4818 | 4928 |
| 5th order IMD products | 2\*f1\_low – 3\*f2\_high | 2\*f1\_high - 3\*f2\_low | 2\*f2\_low – 3\*f1\_high | 2\*f2\_high – 3\*f1\_low |
| IMD frequency limit (MHz) | -3786 | -3556 | 1059 | 1229 |
| 5th order IMD products | 2\*f1\_low + 3\*f2\_low | 2\*f1\_high + 3\*f2\_high | 2\*f2\_low + 3\*f1\_low | 2\*f2\_high + 3\*f1\_high |
| IMD frequency limit (MHz) | 6684 | 6914 | 5751 | 5921 |

Table 5.11.2-1 concludes that no harmonic or IMD product up to 5th order falls into UE’s own DL bands.

The spurious emission towards UE coexisting bands are specified for Regions 3 from band 13 and 66 coexistence.

Table 5.11.2-2: Requirements for uplink inter-band carrier aggregation CA\_13-66

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA Configuration | Spurious emission | | | | | | |
| Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| CA\_13-66 | E-UTRA Band 2, 4, 5, 10, 12, 13, 17, 25, 26, 27, 29, 41, 50, 51, 53, 66, 70, 71, 74, 85 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 14 | FDL\_low | - | FDL\_high | -50 | 1 | 3 |
| E-UTRA Band 24, 30, 48 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| Frequency range | 769 | - | 775 | -35 | 0.00625 | 3 |
| Frequency range | 799 | - | 805 | -35 | 0.00625 | 3, 9 |
| NOTE 2: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 3: 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 9: Whether the applicable frequency range should be 793-805MHz instead of 799-805MHz is TBD. | | | | | | | |

### 5.11.3 ∆TIB and ∆RIB values

The ΔTIB,c and ΔRIB,c values for two-band CA\_13-66 are already specified in TS 36.101 Table 6.2.5-2 (two bands) for ΔTIB,c and Table 7.3.1-1A (two bands) for ΔRIB,c.

### 5.11.4 REFSENS requirements

Since there is no harmonic or IMD relation, no MSD is required due to harmonic or IMD.

## 5.12 CA\_14-30

### 5.12.1 Channel bandwidths per operating band for CA

Table 5.12.1-1: Inter-band CA operating bands

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| E‑UTRA Operating Band | Uplink (UL) operating band BS receive UE transmit | | | Downlink (DL) operating band BS transmit  UE receive | | | Duplex Mode |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | |
| 14 | 788 MHz | – | 798 MHz | 758 MHz | – | 768 MHz | FDD |
| 30 | 2305 MHz | – | 2315 MHz | 2350 MHz | – | 2360 MHz | FDD |

Table 5.12.1-2: Supported E-UTRA bandwidths per CA configuration for inter-band CA

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA configuration / Bandwidth combination set | | | | | | | | | | |
| E-UTRA CA Configuration | Uplink CA configurations | E-UTRA Bands | 1.4 MHz | 3 MHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | Maximum aggregated bandwidth  [MHz] | Bandwidth combination set |
| CA\_14A-30A | CA\_14A-30A | 14 |  |  | Yes | Yes |  |  | 20 | 0 |
| 30 |  |  | Yes | Yes |  |  |

### 5.12.2 Co-existence studies

The following table shows the 2 UL harmonics and IMD products of band 14 and band 30.

**Table 5.12.2-1: CA\_2A-14A UL harmonics and IMD products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| UE UL carriers | f1\_low | f1\_high | f2\_low | f2\_high |
| UL frequencies (MHz) | 788 | 798 | 2305 | 2315 |
| 2nd harmonic | 2\* f1\_low | 2\*f1\_high | 2\*f2\_low | 2\*f2\_high |
| harmonic frequency limit (MHz) | 1576 | 1596 | 4610 | 4630 |
| 3rd harmonic | 3\* f1\_low | 3\*f1\_high | 3\*f2\_low | 3\*f2\_high |
| harmonic frequency limit (MHz) | 2364 | 2394 | 6915 | 6945 |
| 2nd order IMD products | f2\_low – f1\_high | f2\_high – f1\_low | f2\_low + f1\_low | f2\_high + f1\_high |
| IMD frequency limit (MHz) | 1507 | 1527 | 3093 | 3113 |
| 3rd order IMD products | 2\*f1\_low – f2\_high | 2\*f1\_high – f2\_low | 2\*f2\_low – f1\_high | 2\*f2\_high – f1\_low |
| IMD frequency limit (MHz) | -739 | -709 | 3812 | 3842 |
| 3rd order IMD products | 2\*f1\_low + f2\_low | 2\*f1\_high + f2\_high | 2\*f2\_low + f1\_low | 2\*f2\_high + f1\_high |
| IMD frequency limit (MHz) | 3881 | 3911 | 5398 | 5428 |
| 4th order IMD products | 3\*f1\_low – f2\_high | 3\*f1\_high – f2\_low | 3\*f2\_low – f1\_high | 3\*f2\_high – f1\_low |
| IMD frequency limit (MHz) | 49 | 89 | 6117 | 6157 |
| 4th order IMD products | 3\*f1\_low + f2\_low | 3\*f1\_high + f2\_high | 3\*f2\_low + f1\_low | 3\*f2\_high + f1\_high |
| IMD frequency limit (MHz) | 4669 | 4709 | 7703 | 7743 |
| 4th order IMD products | 2\*f1\_low – 2\*f2\_high | 2\*f1\_high – 2\*f2\_low | 2\*f1\_low + 2\*f2\_low | 2\*f1\_high + 2\*f2\_high |
| IMD frequency limit (MHz) | -3054 | -3014 | 6186 | 6226 |
| 5th order IMD products | f1\_low – 4\*f2\_high | f1\_high – 4\*f2\_low | f2\_low – 4\*f1\_high | f2\_high – 4\*f1\_low |
| IMD frequency limit (MHz) | -8472 | -8422 | -887 | -837 |
| 5th order IMD products | f1\_low + 4\*f2\_low | f1\_high + 4\*f2\_high | f2\_low + 4\*f1\_low | f2\_high + 4\*f1\_high |
| IMD frequency limit (MHz) | 10008 | 10058 | 5457 | 5507 |
| 5th order IMD products | 2\*f1\_low – 3\*f2\_high | 2\*f1\_high - 3\*f2\_low | 2\*f2\_low – 3\*f1\_high | 2\*f2\_high – 3\*f1\_low |
| IMD frequency limit (MHz) | -5369 | -5319 | 2216 | 2266 |
| 5th order IMD products | 2\*f1\_low + 3\*f2\_low | 2\*f1\_high + 3\*f2\_high | 2\*f2\_low + 3\*f1\_low | 2\*f2\_high + 3\*f1\_high |
| IMD frequency limit (MHz) | 8491 | 8541 | 6974 | 7024 |

Table 5.12.2-1 concludes that no harmonic or IMD product up to 5th order falls into UE’s own DL bands.

The spurious emission towards UE coexisting bands are specified for Regions 3 according to band 14 and band 66 coexisting bands.

Table 5.12.2-2: Requirements for uplink inter-band carrier aggregation CA\_14-30

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA Configuration | Spurious emission | | | | | | |
| Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| CA\_14-30 | E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 24, 25, 26, 27, 29, 30, 41, 48, 53, 66, 70, 71, 85 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| Frequency range | 769 | - | 775 | -35 | 0.00625 | 3 |
| Frequency range | 799 | - | 805 | -35 | 0.00625 | 3, 9 |
| NOTE 3: 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 9: Whether the applicable frequency range should be 793-805MHz instead of 799-805MHz is TBD. | | | | | | | |

### 5.12.3 ∆TIB and ∆RIB values

The ΔTIB,c and ΔRIB,c values for two band CA\_14-30 are already specified in TS 36.101 Table 6.2.5-2 (two bands) for ΔTIB,c and Table 7.3.1-1A (two bands) for ΔRIB,c.

### 5.12.4 REFSENS requirements

Since there is no harmonic or IMD relation, no MSD is required due to harmonic or IMD.

## 5.13 CA\_14-66

### 5.13.1 Channel bandwidths per operating band for CA

Table 5.13.1-1: Inter-band CA operating bands

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| E‑UTRA Operating Band | Uplink (UL) operating band BS receive UE transmit | | | Downlink (DL) operating band BS transmit  UE receive | | | Duplex Mode |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | |
| 14 | 788 MHz | – | 798 MHz | 758 MHz | – | 768 MHz | FDD |
| 66 | 1710 MHz | – | 1780 MHz | 2110 MHz | – | 2200 MHz | FDD |

Table 5.13.1-2: Supported E-UTRA bandwidths per CA configuration for inter-band CA

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA configuration / Bandwidth combination set | | | | | | | | | | |
| E-UTRA CA Configuration | Uplink CA configurations | E-UTRA Bands | 1.4 MHz | 3 MHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | Maximum aggregated bandwidth  [MHz] | Bandwidth combination set |
| CA\_14A-66A | CA\_14A-66A | 14 |  |  | Yes | Yes |  |  | 30 | 0 |
| 66 |  |  | Yes | Yes | Yes | Yes |

### 5.13.2 Co-existence studies

The following table shows the 2 UL harmonics and IMD products of band 14 and band 66.

**Table 5.13.2-1: CA\_14A-66A UL harmonics and IMD products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| UE UL carriers | f1\_low | f1\_high | f2\_low | f2\_high |
| UL frequencies (MHz) | 788 | 798 | 1710 | 1780 |
| 2nd harmonic | 2\* f1\_low | 2\*f1\_high | 2\*f2\_low | 2\*f2\_high |
| harmonic frequency limit (MHz) | 1576 | 1596 | 3420 | 3560 |
| 3rd harmonic | 3\* f1\_low | 3\*f1\_high | 3\*f2\_low | 3\*f2\_high |
| harmonic frequency limit (MHz) | 2364 | 2394 | 5130 | 5340 |
| 2nd order IMD products | f2\_low – f1\_high | f2\_high – f1\_low | f2\_low + f1\_low | f2\_high + f1\_high |
| IMD frequency limit (MHz) | 912 | 992 | 2498 | 2578 |
| 3rd order IMD products | 2\*f1\_low – f2\_high | 2\*f1\_high – f2\_low | 2\*f2\_low – f1\_high | 2\*f2\_high – f1\_low |
| IMD frequency limit (MHz) | -204 | -114 | 2622 | 2772 |
| 3rd order IMD products | 2\*f1\_low + f2\_low | 2\*f1\_high + f2\_high | 2\*f2\_low + f1\_low | 2\*f2\_high + f1\_high |
| IMD frequency limit (MHz) | 3286 | 3376 | 4208 | 4358 |
| 4th order IMD products | 3\*f1\_low – f2\_high | 3\*f1\_high – f2\_low | 3\*f2\_low – f1\_high | 3\*f2\_high – f1\_low |
| IMD frequency limit (MHz) | 584 | 684 | 4332 | 4552 |
| 4th order IMD products | 3\*f1\_low + f2\_low | 3\*f1\_high + f2\_high | 3\*f2\_low + f1\_low | 3\*f2\_high + f1\_high |
| IMD frequency limit (MHz) | 4074 | 4174 | 5918 | 6138 |
| 4th order IMD products | 2\*f1\_low – 2\*f2\_high | 2\*f1\_high – 2\*f2\_low | 2\*f1\_low + 2\*f2\_low | 2\*f1\_high + 2\*f2\_high |
| IMD frequency limit (MHz) | -1984 | -1824 | 4996 | 5156 |
| 5th order IMD products | f1\_low – 4\*f2\_high | f1\_high – 4\*f2\_low | f2\_low – 4\*f1\_high | f2\_high – 4\*f1\_low |
| IMD frequency limit (MHz) | -6332 | -6042 | -1482 | -1372 |
| 5th order IMD products | f1\_low + 4\*f2\_low | f1\_high + 4\*f2\_high | f2\_low + 4\*f1\_low | f2\_high + 4\*f1\_high |
| IMD frequency limit (MHz) | 7628 | 7918 | 4862 | 4972 |
| 5th order IMD products | 2\*f1\_low – 3\*f2\_high | 2\*f1\_high - 3\*f2\_low | 2\*f2\_low – 3\*f1\_high | 2\*f2\_high – 3\*f1\_low |
| IMD frequency limit (MHz) | -3764 | -3534 | 1026 | 1196 |
| 5th order IMD products | 2\*f1\_low + 3\*f2\_low | 2\*f1\_high + 3\*f2\_high | 2\*f2\_low + 3\*f1\_low | 2\*f2\_high + 3\*f1\_high |
| IMD frequency limit (MHz) | 6706 | 6936 | 5784 | 5954 |

Table 5.13.2-1 concludes that no harmonic or IMD product up to 5th order falls into UE’s own DL bands.

The spurious emission towards UE coexisting bands are specified for Regions 3 according to band 14 and band 66 coexisting bands.

Table 5.13.2-2: Requirements for uplink inter-band carrier aggregation CA\_14-66

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA Configuration | Spurious emission | | | | | | |
| Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| CA\_14-66 | E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 24, 25, 26, 27, 29, 30, 41, 53, 66, 70, 71, 85 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 48 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| Frequency range | 769 | - | 775 | -35 | 0.00625 | 3 |
| Frequency range | 799 | - | 805 | -35 | 0.00625 | 3, 9 |
| NOTE 2: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 9: Whether the applicable frequency range should be 793-805MHz instead of 799-805MHz is TBD. | | | | | | | |

### 5.13.3 ∆TIB and ∆RIB values

The ΔTIB,c and ΔRIB,c values for two band CA\_14-66 are already specified in TS 36.101 Table 6.2.5-2 (two bands) for ΔTIB,c and Table 7.3.1-1A (two bands) for ΔRIB,c.

### 5.13.4 REFSENS requirements

Since there is no harmonic or IMD relation, no MSD is required due to harmonic or IMD.

## 5.14 CA\_1A-7A-7A BCS1

### 5.14.1 Channel bandwidths per operating band

Table 5.14.1-1: E-UTRA CA configurations and bandwidth combination sets

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA configuration / Bandwidth combination set | | | | | | | | | | |
| E-UTRA CA Configuration | Uplink CA configurations | E-UTRA Bands | 1.4 MHz | 3 MHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | Maximum aggregated bandwidth  [MHz] | Bandwidth combination set |
| CA\_1A-7A-7A | CA\_1A-7A | 1 |  |  | Yes | Yes | Yes | Yes | 60 | 1 |
| 7 | See CA\_7A-7A Bandwidth Combination Set 1 in Table 5.6A.1-3 | | | | | |

### 5.14.2 UE co-existence studies

Coexistence studies are covered by CA\_1A-7A-7A BCS0.

### 5.14.3∆TIB and ∆RIB values

∆TIB,c and ∆RIB,c values are covered by CA\_1A-7A-7A BCS0.

### 5.14.4 REFSENS requirements

No additional REFSENS exceptions are expected for this CA combination.

## 5.15 CA\_1-41

### 5.15.1 Channel bandwidths per operating band for CA

Table 5.15.1-1: Inter-band CA operating bands

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| E‑UTRA Operating Band | Uplink (UL) operating band BS receive UE transmit | | | Downlink (DL) operating band BS transmit  UE receive | | | Duplex Mode |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | |
| 1 | 1920 MHz | – | 1980 MHz | 2110 MHz | – | 2170 MHz | FDD |
| 41 | 2496 MHz | – | 2690 MHz | 2496 MHz | – | 2690 MHz | TDD |

Table 5.15.1-2: Supported E-UTRA bandwidths per CA configuration for inter-band CA

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA configuration / Bandwidth combination set | | | | | | | | | | |
| E-UTRA CA Configuration | Uplink CA configurations | E-UTRA Bands | 1.4 MHz | 3 MHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | Maximum aggregated bandwidth  [MHz] | Bandwidth combination set |
| CA\_1A-41C | CA\_1A-41A  CA\_1A\_41C | 1 |  |  | Yes | Yes | Yes | Yes | 60 | 0 |
| 41 | See CA\_41C Bandwidth Combination Set 1 in Table 5.6A.1-1 | | | | | |

### 5.15.2 Co-existence studies

Table 5.x.2-1 shows the 2nd, 3rd, 4th and 5th order IMD of the CA\_1A-41C with 2UL bands and the UE-to-UE coexistence analysis.

Table 5.15.2-1: Band x and Bandy 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) | 516 – 770 | | | 4416 – 4670 | | |
| 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) | 1150 – 1464 | | | 3012 – 3460 | | |
| 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) | 6336 – 6650 | | | 6912 – 7360 | | |
| 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) | 3070 – 3444 | | | 5508 – 6150 | | |
| 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) | 1032 – 1540 | | | 8832– 9340 | | |
| 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) | 8256 – 8630 | | | 9408 – 10050 | | |
| 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) | 8004 – 8840 | | | 4990 – 5424 | | |
| 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) | 3528 – 4230 | | | 380 – 948 | | |
| 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) | 11904 – 12740 | | | 10176 – 10610 | | |
| 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) | 11328 – 12030 | | | 10752 – 11320 | | |
| 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. | | | | | | |

It can be seen from Table 5.15.2-1 that there is no IMD impact towards any of its own downlink bands.

Table 5.15.2-2 lists the protected bands required for the 2UL bands CA configuration.

Table 5.15.2-2: Protected bands for the 2UL bands CA configuration

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| UL E-UTRA CA Configuration | Spurious emission | | | | | | |
| Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| CA\_1-41 | E-UTRA Band 1, 3, 5, 8, 26, 27, 28, 40, 42, 44, 45, 50, 51, 52, 65, 73, 74,  NR Band n78 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 34 | FDL\_low | - | FDL\_high | -50 | 1 | 15 |
| NR Band n77, n79 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| E-UTRA Band 11, 18, 19, 21 | FDL\_low | - | FDL\_high | -50 | 1 | 30 |
| Frequency range | 1880 |  | 1895 | -40 | 1 | 15，27 |
| Frequency range | 1895 |  | 1915 | -15.5 | 5 | 15，26，27 |
| Frequency range | 1915 |  | 1920 | +1.6 | 5 | 15，26，27，44 |
| Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 8，30 |

### 5.15.3 ΔTIB,c and ΔRIB,c values

CA\_1A-41C has the same ΔTIB,c and ΔRIB,c  as existing combination CA\_1A-41A.

Table 5.15.3-1: ΔTIB,c for 2DLs aggregation

|  |  |  |
| --- | --- | --- |
| Inter-band CA Configuration | E-UTRA Band | ΔTIB,c [dB] |
| CA\_1-41 | 1 | 0.5 |
| 41 | 0.5 |

Table 5.15.3-2: ΔRIB,c for 2DLs aggregation

|  |  |  |
| --- | --- | --- |
| Inter-band CA Configuration | E-UTRA Band | ΔRIB,c [dB] |
| CA\_1-41 | 1 | 0 |
| 41 | 0 |

5.15.4 REFSENS requirements

Since there is no IMD relation, no MSD is required due to IMD.

## 5.16 CA\_18-41

### 5.16.1 Channel bandwidths per operating band for CA

Table 5.16.1-1: Inter-band CA operating bands

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| E‑UTRA Operating Band | Uplink (UL) operating band BS receive UE transmit | | | Downlink (DL) operating band BS transmit  UE receive | | | Duplex Mode |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | |
| 18 | 815 MHz | – | 830 MHz | 860 MHz | – | 875 MHz | FDD |
| 41 | 2496 MHz | – | 2690 MHz | 2496 MHz | – | 2690 MHz | TDD |

Table 5.16.1-2: Supported E-UTRA bandwidths per CA configuration for inter-band CA

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA CA configuration / Bandwidth combination set | | | | | | | | | | |
| E-UTRA CA Configuration | Uplink CA configurations | E-UTRA Bands | 1.4 MHz | 3 MHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | Maximum aggregated bandwidth  [MHz] | Bandwidth combination set |
| CA\_18A-41A | CA\_18A-41A | 18 |  |  | Yes | Yes | Yes |  | 35 | 0 |
| 41 |  |  | Yes | Yes | Yes | Yes |
| CA\_18A-41C | CA\_18A-41A  CA\_18A-41C | 18 |  |  | Yes | Yes | Yes |  | 55 | 0 |
| 41 | See CA\_41C Bandwidth Combination Set 1 in Table 5.6A.1-1 | | | | | |

### 5.16.2 Co-existence studies

Table 5.16.2-1 shows the 2nd, 3rd, 4th and 5th order IMD of the CA\_18-41 with 2UL bands and the UE-to-UE coexistence analysis.

Table 5.16.2-1: Band x and Bandy 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) | 1666 – 1875 | | | 3311 – 3520 | | |
| 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) | 836 – 1060 | | | 4162 – 4565 | | |
| 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) | 4126 – 4350 | | | 6912 – 7360 | | |
| 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) | 6 – 245 | | | 6658 – 7255 | | |
| 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) | 3332 – 3750 | | | 6622– 7040 | | |
| 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) | 4941 – 5180 | | | 8303– 8900 | | |
| 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) | 9154 – 9945 | | | 570 – 824 | | |
| 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) | 5828 – 6440 | | | 2502 – 2935 | | |
| 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) | 10799 – 11590 | | | 5756 – 6010 | | |
| 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) | 9118 – 9730 | | | 7437 – 7870 | | |
| 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. | | | | | | |

It can be seen from Table 5.16.2-1 that

- The 3rd order IMD may fall into the Rx of Band18，

- The 5th order IMD may fall into the Rx of Band 41, since B41 is a TDD band, there is no IMD impact.

- The 3rd harmonic mixing may fall into The Rx of Band 18..

Since B18 only was used in Japan, considering KDDI’s spectrum, there is no IMD impact to Band 18.

Table 5.16.2-2 lists the protected bands required for the 2UL bands CA configuration.

Table 5.16.2-2: Protected bands for the 2UL bands CA configuration

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| UL E-UTRA CA Configuration | Spurious emission | | | | | | |
| Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| CA\_18-41 | E-UTRA Band 1, 3, 34, 42, 65 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 11, 21 | FDL\_low | - | FDL\_high | -50 | 1 | 30 |
| NR Band n77, n78, n79 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| Frequency range | 758 | - | 799 | -50 | 1 |  |
| Frequency range | 799 | - | 803 | -40 | 1 | 15 |
| Frequency range | 860 | - | 890 | -40 | 1 |  |
| Frequency range | 945 | - | 960 | -50 | 1 |  |
| Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 8, 30 |
| Frequency range | 2545 | - | 2575 | -50 | 1 |  |
| Frequency range | **2595** | - | 2645 | -50 | 1 |  |

### 5.16.3 ΔTIB,c and ΔRIB,c values

CA\_18-41 has the same ΔTIB,c and ΔRIB,c  as defined for CA\_18A-41A.

Table 5.16.3-1: ΔTIB,c for 2DLs aggregation

|  |  |  |
| --- | --- | --- |
| Inter-band CA Configuration | E-UTRA Band | ΔTIB,c [dB] |
| CA\_18-41 | 18 | 0.3 |
| 41 | 0.3 |

Table 5.16.3-2: ΔRIB,c for 2DLs aggregation

|  |  |  |
| --- | --- | --- |
| Inter-band CA Configuration | E-UTRA Band | ΔRIB,c [dB] |
| CA\_18-41 | 18 | 0 |
| 41 | 0 |

### 5.16.4 REFSENS requirements

Table 5.16.4-1 and Table 5.16.4-2 show the MSD due to harmonic mixing issue and IMD issue separately.

Table 5.16.4-1: Reference sensitivity for carrier aggregation QPSK PREFSENS, CA (exceptions due to harmonic issue)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Channel bandwidth | | | | | | | | |
| EUTRA CA Configuration | EUTRA band | 1.4 MHz (dBm) | 3 MHz (dBm) | 5 MHz (dBm) | 10 MHz (dBm) | 15 MHz (dBm) | 20 MHz (dBm) | Duplex mode |
| CA\_18A-41A19  CA\_18A-41C19 | 41 |  |  | N/A | N/A | N/A | N/A | TDD |
| NOTE 19: No requirements apply for the case that there is at least one individual RE within the uplink transmission bandwidth of the relative higher band and when the frequency range of relative higher band’s uplink channel bandwidth or uplink 1st adjacent channel bandwidth is fully or partially overlapped with the 3 times of the frequency range of the relative lower band’s downlink channel bandwidth. The reference sensitivity is only verified when this is not the case (the requirements specified in clause 7.3.1 apply). | | | | | | | | |

Table 5.16.4-2 2DL/2UL interband Reference sensitivity QPSK PREFSENS and uplink/downlink configurations

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA Band / Channel bandwidth / NRB / Duplex mode | | | | | | | | Source of IMD |
| EUTRA CA  Configuration | EUTRA band | UL Fc  (MHz) | UL/DL BW  (MHz) | UL  CLRB | DL Fc (MHz) | MSD  (dB) | Duplex mode |
| CA\_18A-41A  CA\_18A-41C | 18 | N/A | N/A | N/A | N/A | N/A1 | FDD | IMD3 |
| 41 | N/A | N/A | N/A | N/A | N/A | TDD | N/A |
| Note1: no MSD requirement apply, when the uplink channel in B41 is located at the frequency range of 2595MHz-2645MHz. | | | | | | | | |

# Annex A: Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **TSG #** | **TSG Doc.** | **CR** | **Rev** | **Subject/Comment** | **Old** | **New** |
| 2018-08 | 3GPP RAN4#88 | R4-1811191 |  |  | Initial TR skeleton |  | 0.0.1 |
| 2018-10 | 3GPP RAN4#88bis | R4-1813405 |  |  | R4-1811445, TP for TR 36.716-02-02: CA\_3-11 | 0.0.1 | 0.1.0 |
| 2018-11 | 3GPP RAN4#89 | R4-1815905 |  |  |  | 0.1.0 | 0.2.0 |
| 2019-02 | 3GPP RAN4#90 | R4-1901358 |  |  | R4-1815806, TP to TR 36.716-02-02: Addition of CA configuration for 26-48 UL | 0.2.0 | 0.3.0 |
| 2019-03 | 3GPP RAN4#91 | R4-1905675 |  |  | R4-1904904, TP for 36.716-02-02 on 2BUL\_25A-41A\_BCS0  R4-1903283, TP for 36.716-02-02 on 2BUL\_25A-26A\_BCS0 | 0.3.0 | 0.4.0 |
| 2019-05 | 3GPP RAN4#92 | R4-1909906 |  |  | R4-1907396, TP for TR 36.716-02-02 to include LTE CA\_48-66 with 48-66 UL  R4-1907395, TP for TR 36.716-02-02 to include LTE CA\_2-48 with 2-48 UL  R4-1905887, TP for TR 36.716-02-02 Introduction of CA\_2-14  R4-1907414, TP for TR 36.716-02-02 Introduction of CA\_4-28  R4-1907415, TP for TR 36.716-02-02 Introduction of CA\_13-66  R4-1907416, TP for TR 36.716-02-02 Introduction of CA\_14-30  R4-1907417, TP for TR 36.716-02-02 Introduction of CA\_14-66  R4-1906462, TP for TR 36.716-02-02: adding CA\_1-7-7 BCS1 | 0.4.0 | 0.5.0 |
| 2020-05 | 3GPP RAN4#95-e | R4-2008235 |  |  | R4-2005038, TP for TR 36.716-02-02: CA\_1A-41C  R4-2005039, TP for TR 36.716-02-02: CA\_18-41 | 0.5.0 | 0.6.0 |
| 2020-06 | 3GPP RAN#88-e | RP-200878 |  |  | TR 36.716-02-02 v1.0.0 | 0.6.0 | 1.0.0 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2020-06 | RAN#88 |  |  |  |  | Approved by plenary – Rel-16 spec under change control | 16.0.0 |