|  |
| --- |
| 3GPP RAN4 PRD 01 v0.5.0 (2025-10) |
| Permanent Reference Document |
| 3rd Generation Partnership Project;Technical Specification Group RAN WG4;Permanent Reference Document (PRD);Rules, guidelines and ways of working for introduction of band combinations in NR and LTE(Release 19 and later releases) |
|   |
|  |  |
|  |
| The present document has been developed within the 3rd Generation Partnership Project (3GPP TM) and may be further elaborated for the purposes of 3GPP.The present document has not been subject to any approval process by the 3GPPOrganizational Partners and shall not be implemented.This Specification is provided for future development work within 3GPPonly. The Organizational Partners accept no liability for any use of this Specification.Specifications and Reports for implementation of the 3GPP TM system should be obtained via the 3GPP Organizational Partners' Publications Offices. |

|  |
| --- |
|  |
| ***3GPP***Postal address3GPP support office address650 Route des Lucioles - Sophia AntipolisValbonne - FRANCETel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16Internethttp://www.3gpp.org |
| ***Copyright Notification***No part may be reproduced except as authorized by written permission.The copyright and the foregoing restriction extend to reproduction in all media.© 2021, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC).All rights reserved.UMTS™ is a Trade Mark of ETSI registered for the benefit of its members3GPP™ is a Trade Mark of ETSI registered for the benefit of its Members and of the 3GPP Organizational PartnersLTE™ is a Trade Mark of ETSI registered for the benefit of its Members and of the 3GPP Organizational PartnersGSM® and the GSM logo are registered and owned by the GSM Association |

Contents

Foreword 4

Foreword 6

Introduction 7

1 Scope 8

2 References 8

3 Definitions of terms, symbols and abbreviations 8

3.1 Terms 8

3.2 Symbols 9

3.3 Abbreviations 9

4 Working procedure of specifying band combinations 10

4.1 General 10

4.2 Band combination request 10

4.2.1 Band combination workflow 10

4.2.1.1 The workflow on introduction of band combinations for block approval 10

4.2.2 Request sheets and work item descriptions 11

4.2.2.1 Template for requesting band combinations 11

4.2.2 Templates for high power UE band combinations 13

4.3 Fallback aspects for specifying band combinations 13

4.3.1 General definition of fallbacks 14

4.3.2 Mandatory Fallbacks 15

4.3.3 Fallbacks of EN-DC Configurations 16

4.3.4 Fallbacks of UL Configurations 16

4.3.5 Fallback rules for some exceptional cases 17

4.3.6 Guidelines on valid CBW for higher order BC depending on fallbacks 17

4.4 Submitting technical contributions (Tdoc) for specifying band combinations 17

4.4.1 Text Proposal (TP) or Draft Change Request (draft CR) 17

4.4.2 Specific for Text Proposal (TP) 17

4.4.3 Specific for Draft Change Request (draft CR) 18

4.4.4 Which agenda to submit the Tdoc for 18

5 Guidelines of specifying band combinations 18

5.1 General 18

5.2 Notation of lists of bands and bandwidths within a configuration 19

5.2.1 Band numbers 19

5.2.2 Bandwidth classes 20

5.2.2.1 Bandwidth classes for LTE 20

5.2.2.2 Bandwidth classes for NR 20

5.3 Rules to be used for the notation of CA or DC configurations 21

5.4 Guidelines on ΔTIB and ΔRIB 22

5.4.1 General 22

5.4.2 2 band CA/DC ΔTIB,c and ΔRIB,c 22

5.4.3 More than 2 band CA/DC ΔTIB,c and ΔRIB,c 23

5.4.4 Exceptions of ΔTIB and ΔRIB for specific band combinations 23

5.4.5 Inclusion of ΔTIB and ΔRIB to the specification 23

5.5 Guidelines on MSD 24

5.5.1 Intra-band CA 24

5.5.1.1 One Uplink CC 24

5.5.1.2 Two Uplink CCs 25

5.5.2 Inter-band CA 25

5.5.2.1 Two-band Inter-band Downlink CA 25

5.5.2.2 Three-band DL CA 29

5.6 Guidelines on MPR 29

5.7 Adding or removing channel BW’s in NR CA configurations 29

5.7.1 Adding channel BW’s in NR CA configurations 29

5.7.2 Removing channel BW’s in NR CA configurations 30

5.7.2.1 Removing of not possible channel BW’s 30

5.7.2.2 Removing of possible channel BW’s 30

5.7.3 Introduction of BCS4/BCS5 30

5.7.3.1 Guidelines for band combination with BCS4/BCS5 31

5.7.3.2 The maximum aggregated bandwidth for intra-band CA with BCS4/BCS5 32

5.8 Guidelines on drafting band combination tables 32

5.8.1 General on table notes draftings 32

5.8.2 Guidelines on simplification for CA configurations 32

5.8.3 Guidelines on grouping for DC configurations 33

Annex A (informative): Change history 33

# Foreword

This Permanent Reference Document (PRD) has been produced by the 3rd Generation Partnership Project (3GPP) TSG RAN Working Group 4 (RAN WG4 = RAN4).

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.

# Introduction

PRD01 describes the working procedures for introduction of band combinations in NR and LTE.

At 3GPP RAN4#112 meeting it was agreed to start a permanent reference document (PRD) to capture. The original first baseline for PRD01 was created using the technical report 38.846 V18.1.0 produced in the RAN4 Rel-18 study item for band combination simplification.

# 1 Scope

The present document is a Permanent Reference Document with the purpose of capturing the working procedures and the rules for how to specify band combinations for NR and LTE.

# 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-221790, “Revised SID: Study on simplification of band combination specification for NR and LTE”, RAN#96.

[3] 3GPP TR 38.817-01: “General aspects for User Equipment (UE) Radio Frequency (RF) for NR”.

[4] 3GPP TS 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".

[5] 3GPP TS 38.101-2: "NR; User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone".

[6] 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".

[7] TR38.862: "Study on band combination handling in RAN4".

[8] RP-202832, “New WID: Introduction of bandwidth combination set 4 (BCS4) for NR”, RAN#90-e.

[9] R4-2220556, WF on triple beat rules and MSD for inter-band with 2UL with intra-band ULCA, RAN4#105.

# 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].

**Aggregated Channel Bandwidth**: The RF bandwidth in which a UE transmits and receives multiple contiguously aggregated carriers.

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

**Carrier aggregation band**: A set of one or more operating bands across which multiple carriers are aggregated with a specific set of technical requirements.

**Carrier aggregation bandwidth class**: A class defined by the aggregated transmission bandwidth configuration and maximum number of component carriers supported by a UE.

**Carrier aggregation configuration**: A combination of CA operating band(s) and CA bandwidth class(es) supported by a UE.

**Contiguous carriers**: A set of two or more carriers configured in a spectrum block where there are no RF requirements based on co-existence for un-coordinated operation within the spectrum block.

**Fallback group:** Group of carrier aggregation bandwidth classes for which it is mandatory for a UE to be able to fallback to lower order CA bandwidth class configuration. It is not mandatory for a UE to be able to fallback to lower order CA bandwidth class configuration that belong to a different fallback group.

**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.

**Intra-band contiguous carrier aggregation**: Contiguous carriers aggregated in the same operating band.

**Intra-band non-contiguous carrier aggregation**: Non-contiguous carriers aggregated in the same operating band.

**Sub-block:** This is one contiguous allocated block of spectrum for transmission and reception by the same UE. There may be multiple instances of sub-blocks within an RF bandwidth.

## 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*

BWChannel Channel bandwidth

BWChannel\_CA Aggregated channel bandwidth, expressed in MHz

NRB Transmission bandwidth configuration, expressed in units of resource blocks

## 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].

BCS Bandwidth Combination Set

BS Base Station

BW Bandwidth

CA Carrier Aggregation

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

CC Component carrier

DC Dual Connectivity

DL DownLink

E-UTRA Evolved Universal Terrestrial Radio Access

EN-DC E-UTRA/NR DC

FDD Frequency Division Duplex

IMD Inter-modulation

LTE Long Term Evolution

MR-DC Multi-radio DC

MSD Maximum Sensitivity Deduction

NE-DC NR/E-UTRA DC

NR New Radio

NR-DC NR/NR DC

RF Radio Frequency

Rx Receiver

SCS Subcarrier spacing

TDD Time Division Duplex

Tx Transmitter

UE User Equipment

UL UpLink

V2X Vehicle to Everything

# 4 Working procedure of specifying band combinations

## 4.1 General

TBD

## 4.2 Band combination request

### 4.2.1 Band combination workflow

#### 4.2.1.1 The workflow on introduction of band combinations for block approval

In order to improve the efficiency of RAN4’s work, it’s necessary to introduce a clear workflow on the introduction of band combinations for block approval. The workflow on the introduction of band combinations for block approval is shown as figure 5.1A.1.1-1 as a typical example for one RAN4 meeting in one quarter. The specific steps are listed as below.

#1 Band combinations should be requested by contact person using request template. And the request spread sheet should be shared in the reflector 3GPP\_TSG\_RAN\_WG4\_NR\_BANDS for NR CA, MR DC and SUL band combinations or 3GPP\_TSG\_RAN\_WG4\_CA for LTE CA band combinations before RAN4#(X-1) meeting.

#2 Band combinations should be captured into the draft revised WIDs during RAN4#(X-1) meeting by rapporteurs.

#3 The official revised basket WIDs can be approved together with requested band combinations during RAN#(Y-1) meeting.

#4 Proponents should prepare and submit the corresponding contributions, e.g. draft CR, TP before RAN4#X meeting. If a draft CR or TP is depending on approval of lower order fallbacks submitted at the same meeting, this need to be clearly mentioned in the cover sheet of the draft CR or in the heading of the TP.

#5 The Block/Approval procedure is applicable to the band combinations in one week before formal RAN4#X meeting, if there is no general issues observed.

#6 The contributions will be discussed during RAN4#X meeting. If there are no technical concerns and if all the needed fallbacks are completed, the band combinations can be approved. And the final decision will be made by chairman.

#7 If the contributions are approved or endorsed, the corresponding band combinations should be captured into the big CRs and/or TRs by rapporteurs. Note: The big CR is an official CR which is used to capture all the corrections for one specification by rapporteur under basket WI.

#8 Email approval can be used for the big CRs and/or TRs in one week after formal RAN4#X meeting.

#9 The status of band combinations is expected to be shared by contact person after formal RAN4#X meeting.

#10 The status of band combinations should be captured into the WID and/or SR by rapporteurs.

#11 RAN #Y will approve the big CRs and revised WIDs.

#12 The agreed band combinations will be introduced into the specification in next version.



Figure 4.2.1.1-1 The workflow on the introduction of band combinations for block approval

### 4.2.2 Request sheets and work item descriptions

The configurations notation discussed in Clause 5 are also used for the CA/DC configurations in the columns for the CA/DC configurations for DL and UL in the request sheets and the combination tables within the WIDs. However, multiple errors within the specifications have been observed, which motivate the need to define the following rules how to implement these band combinations within the CA/DC configurations lists within the excel tables in the request sheets and WIDs:

- Each cell of the CA or DC configuration column in the Excel tables shall contain only one single CA/DC configuration using the notation of the configurations as discussed above

- Similar CA or DC configurations with different bandwidth classes shall use another row in the same column of the table.

- The UL configurations column shall only contain the UL configurations valid for the CA/DC configuration in the same row, if there are multiple valid UL configurations they can be listed one after the other separated with “, ” (a comma followed by a space), but they can also be using a single completely filled row for each of the valid UL configurations

- There shall be no merged cells in the table

- The WI rapporteur checks if the notation of the CA/DC configurations is correct and if not returns the request to the requestor. Incorrect requests should not be added to the table in the WID.

#### 4.2.2.1 Template for requesting band combinations

Some general rules are listed about the Excel spread sheet template.

#1 The Excel spread sheet can be used as the templates of request sheet, status report, and band combinations table in basket WI. The templates can be found in the following 3GPP ftp server.

#2 All request table, status report table and band combination index table of basket WID are unified to use one template for band combination information sheet.

#3 Cover sheet which is the first sheet in the template can be only used by Contact Company which needs to request new band combinations or some modifications or report the band combinations’ status instead of the official basket WID or Status Report. Cover sheet can be further updated after additional basket WIs are approved in RAN plenary.

#4 Rapporteurs can choose some of these BCS table sheets to suit their WID. For BCS4/BCS5 there is no need to add information in the BCS sheet since there is no channel BW details to be filled in for them.

#5 Only one sheet/Excel attachment is used for both the WID and the status report by rapporteurs.

#6 The following rules and marks can be used to indicate the change marks for the band combinations in the Excel spread sheet.

1) The Excel sheet included in the status report and the WID would have 2 worksheets.

- Details of band combinations status of RAN #Y-1. It’s the simple copy from last RAN meeting.

- Details of band combinations status of RAN #Y

2) The worksheet of RAN #Y would have an extra column A "Are there any change marks?" which includes 4 words:

**- New** for new if the whole line is new. Those lines could be marked in blue.

**- Modified** for modified if any field in this line is modified. The modified field could be marked in yellow.

**- Deleted** for deleted if the whole line needs to be removed. The whole line could be marked in red.

- **Unchanged** for all the information about combination aren’t changed.

|  |  |
| --- | --- |
| Change marks | Explanation |
| New | Each new row from a contact company request is marked in blue with New in first column. |
| Modified | Some columns of the row are modified. The rapporteur will mark those changed cells in yellow and use Modified in the first column. |
| Deleted | For a removed band combination, the rapporteur marks the row in red and uses Deleted in first column. |
| Unchanged | No changes in any field of the row |

3) How would this Excel sheet be used:

3.1) WID update:

   - Excel lists from RAN #Y-1 are taken, all lines with “Deleted” are removed, all yellow and blue highlights are removed, all words “New” and ” Modified” in "changes" column A are changed to “Unchanged”

       - This provides the updated intermediate Excel lists of RAN #Y-1 and copies of both lists are made to make the intermediate lists for RAN #Y

      If we start this with new release, then the RAN #Y-1 lists would not be needed because there are no new release combinations yet.

   - Now lists of RAN #Y are updated:

       - all new lines coming from contact company requests are inserted and marked in blue with “New” in first line

       - There may be some to be modified, so rapporteur will mark changed fields in yellow and use “Modified” in first column

       - There may be a few to be deleted, so rapporteur marks the line in red and uses “Deleted” in first column

- If all the information about combination aren’t changed, rapporteur marks the line in unfilled colour and uses “Unchanged” in first column.

- For the changes in the BCS sheet, rapporteurs and proponent can mark change fields in yellow.

3.2) Status Report update:

 - Assuming the WID update Excel list is ready after the RAN4 meeting,

        The rapporteur can use the same Excel list for the status report: i.e.

         - Contact companies can easily filter for ongoing combinations of their company and then

             - Leave the line unchanged if all the information about combination aren’t changed.

             - Change the status to completed, fill in column A~T, then these mark all these modified field in yellow and indicate Modified in first column

             - Change the status to stopped, mark this field in yellow and indicate “Modified” in first column.

         - Rapporteurs can check and take over the different inputs into their master copy.

#### 4.2.2 Templates for high power UE band combinations

Specifying HPUE band combination follows the same procedure as PC3 band combination. Request for additions of HPUE band combinations shall be provided by the proponents and sent to the *3GPP\_TSG\_RAN\_WG4\_NR\_BANDS* email reflector before a RAN4 Tdoc submission deadline and no new band combinations are allowed to be requested after the deadline except to correct the missing fallback and add more supporting companies for the proposed band combinations.

Because there is no MSD analysis for FR1+FR2 NR-CA, NR-DC and EN-DC combinations (3x7.125 GHz = 21.375 GHz which is below the lower edge of the TN FR2 range of 24.25 GHz), there is no need to request HPUE for FR1+FR2 combinations, or to document support for HPUE for FR1+FR2 combinations in 38.101-3. The FR1 HPUE requirements for the FR1 fallbacks of FR1+FR2 combinations apply to the FR1 part of FR1+FR2 combinations.

## 4.3 Fallback aspects for specifying band combinations

For companies to propose the new band combinations in the band combination basket WIDs, some restrictions on the fallback aspects should be taken into account. The proponents should propose all the necessary fallback modes together with the proposed band combinations. To make the rules on fallback aspects common understanding in RAN4 and to facilitate delegates who are not very familiar with such rules when preparing the band combination proposals, the following text is suggested to be captured in the justification of each band combination basket WID.

*- Request for additions of band combinations to this WI shall be provided using an agreed template and sent to the 3GPP\_TSG\_RAN\_WG4\_NR\_BANDS email reflector before a RAN4 Tdoc submission deadline and no new band combinations are allowed to be requested after the deadline except to correct the missing fallback and add more supporting companies for the proposed band combinations.*

- *When a proponent requests a new band combination, all the next level fallback configurations shall be listed and recorded in the request template and the status (“New”, “Ongoing”, “Completed”) of all the fallback configurations shall be declared accurately and clearly. For “New” fallback configurations, the proponent shall ensure these fallback configurations are also requested together with the higher order band combination in the same meeting.*

- *A band combination configuration can only be considered as completed when all of the fallback configurations are completed and specified in advance or at the same meeting. It is the responsibility of the proponent to ensure the status of all of the fallback mode configurations. Rapporteurs and other companies are encouraged to check the status of all of the fallback configurations once the higher order band combinations are declared as completed.*

*(Note: 3GPP\_TSG\_RAN\_WG4\_CA is used for the LTE CA baskets WI)* When the below approved rule is not followed by the proponents, TP/draft CR could be flagged by rapporteurs/ interested companies, and the TP/draft CR shall be noted if the lower order fallbacks are missing.

 # Proponents should prepare and submit the corresponding contributions, e.g. draft CR, TP before RAN4#X meeting.

# Proponents should clearly mention the following two conditions in the cover sheet of the draft CR or in the heading of the TP.

1) Whether there are pending lower order fallbacks submitted at the same meeting related to the combos in this draft CR/TP. (Yes with Tdoc numbers or No)

2) Whether there were lower order fallbacks approved in the last meeting related to the combos in this draft CR/TP, if the last meeting is a bis meeting. (Yes with Tdoc numbers or No)

Examples for the cases when the last meeting is a bis meeting:

#1: The draft CRs/or TPs for the fallback combinations in the same meeting: R4-xxxxxxx.
There is no related lower order fallbacks in the last bis meeting.

#2: There is no pending lower order fallbacks in the same meeting.
The draft CRs/or TPs for the fallback combinations in the last bis meeting: R4-xxxxxxx

#3: There is no pending lower order fallbacks in the same meeting.
There is no related lower order fallbacks in the last bis meeting.

#4: The draft CRs/or TPs for the fallback combinations in the same meeting: R4-xxxxxxx.
The draft CRs/or TPs for the fallback combinations in the last bis meeting: R4-xxxxxxx

### 4.3.1 General definition of fallbacks

In the 36.101 and 38.101 specs thousands of band combinations for LTE, EN-DC, NR-DC… are specified having at least two carriers, but in most cases many more than two carriers. There are already many rules and definitions for these configurations.

Definitions:

– A fallback DC, CA or SUL configuration is a configuration, where one of the carriers of the higher order configuration is removed.

– A mandatory fallback is a fallback that is mandatory to be specified in the UE specification and supported by the UE.

– A Fallback Group is specified for contiguous CA, only fallback configurations within the same fallback group need to be supported.

Explanations and rules:

– A higher order configuration has generally the same number of fallbacks as it has carriers, i.e. a configuration with 4 carriers has 4 next level fallbacks.

*-* Example: CA\_n1A-n2A-n3A-n4A has the 4 next level fallbacks CA\_n2A-n3A-n4A, CA\_n1A-n3A-n4A, CA\_n1A-n2A-n4A, CA\_n1A-n2A-n3A, where the first, the second, the third and the fourth carrier have been removed.

- For intra-band CA some of the fallbacks are identical, so that the number of unique fallbacks can be lower than the number of carriers. For contiguous intra-band CA there is only one unique fallback, for non-contiguous intra-band CA as well. For contiguous intra-band configurations removing one of the middle carriers would not result in a valid fallback, since this would transform the contiguous configuration to a non-contiguous configuration. But for the combination of contiguous and non-contiguous intra-band CA there will usually be more than one unique fallback left.

*-* Example: CA\_n1(3A) would have three fallbacks, where the first, the second or the third carrier would be removed, but in all three cases the resulting fallback is the same: CA\_n1(2A), so we only have one unique fallback configuration left out of the three.

*-* Example: CA\_n1D would have three fallbacks, where the first, the second or the third carrier would be removed, but in all three cases the resulting fallback is the same: CA\_n1C, so we only have one unique fallback configuration left out of the three. Additionally removing the middle carrier doesn’t result in a valid fallback, since it would change the contiguous configuration to a non-contiguous one.

*-* Example: CA\_n265R12 would have twelve fallbacks, where the first, the second … twelfth carrier would be removed, but in all twelve cases the resulting fallback is the same: CA\_n265R11, so we only have one unique fallback configuration left out of the twelve. Also here removing one of the middle carrier doesn’t result in a valid fallback, since it would change the contiguous configuration to a non-contiguous one.

*-* Example: CA\_n1(A-C) would have three fallbacks, where the first, the second or the third carrier would be removed, this would result in CA\_n1C, CA\_n1(2A), CA\_n1(2A) as fallbacks, where the last two are duplicates, so in this case we have two unique fallback configurations left out of the three: CA\_n1C and CA\_n1(2A).

- For intra-band contiguous CA we have to follow the fallback groups. Only fallbacks within this group can be used, BW classes outside the fallback group are no legal fallbacks.

- Example: CA\_n1D falls back to CA\_n1C.

*-* Example: CA\_n1C falls back to CA\_n1A, BUT NOT to CA\_n1B, since this is in a different fallback group.

*-* Example: CA\_n265I (FR2) falls back to CA\_n265H, this falls back to CA\_n265G, this falls back to CA\_n265A, NOT to CA\_n265F.

- For combined contiguous and non-contiguous intra-band CA, which is mainly used for FR2, there will be many fallbacks, especially when there is a large number of carriers, but also there some fallbacks after removing a carrier may be duplicates.

*-* Example: CA\_n265(A-G-H), removing the “A” carrier results in CA\_n265(G-H), removing one of the “G” carriers results in CA\_n265(A-A-H), which will be correctly written as CA\_n265(2A-H), removing one of the “H” carrier will result in CA\_n265(A-G-G), which will be correctly written as CA\_n265(A-2G), so we get three unique configurations out of these six carriers.

### 4.3.2 Mandatory Fallbacks

In general all fallbacks need to be specified and supported until we end up at a single carrier. So it is necessary to generate a fallback tree starting at the configuration with the highest number of carriers down to a single carrier.

– A configuration has as many fallback levels as the highest order combination has carriers. For example a four carrier combination will have four three carrier fallbacks, each of these has three two carrier fallbacks, each of these would end up in single carriers. However, in this chain there will again be some duplicates.

Example: CA\_n1A-n2A-n3A-n4An has these fallbacks:

- CA\_n2A-n3A-n4A, CA\_n1A-n3A-n4A, CA\_n1A-n2A-n4A, CA\_n1A-n2A-n3A.

These four combinations have these two carrier fallbacks (colors as above):

- CA\_n3A-n4A, CA\_n2A-n4A, CA\_n2A-n3A, CA\_n3A-n4A, CA\_n1A-n4A, CA\_n1A-n3A, CA\_n2A-n4A, CA\_n1A-n4A, CA\_n1A-n2A, CA\_n2A-n3A, CA\_n1A-n3A, CA\_n1A-n2A.

As we see there are several duplicates, removing these we end up with these second level fallbacks:

- CA\_n3A-n4A, CA\_n2A-n4A, CA\_n2A-n3A, CA\_n1A-n4A, CA\_n1A-n3A, CA\_n1A-n2A.

*-* All of these end up in 4 single carriers of n1A, n2A, n3A and n4A.

- This is a recursive action, we first have to check the next lower level fallbacks, then take these as the basis for the next lower level and so on, until we end up with single carriers.

- All fallbacks for these DC, CA or SUL combinations are mandatory to be supported, as long as the corresponding UL is supported as well.

One relatively simple example of such a combination is DC\_2A\_n261(H-I). But already this simple example generates a fallback tree with 12 fallbacks when going from 8 carriers to a single dual carrier DC combination. This is shown in figure 6.2.2-1:



Figure 4.3.2-1: Fallback tree for DC\_2A\_n261(H-I)

There are much more complicated CA combinations that will create many more combinations like CA\_n260(2A-2O-Q) and there are many of these combinations. For CA\_n260(2A-2O-Q) for example there is a fallback tree with 46 unique fallback combinations (all duplicates already removed). This combination is already in 38.101, however, most of these fallbacks were initially missing and added later.

All of these fallbacks have to be specified in 38.101 specs and need to be supported by the UE.

### 4.3.3 Fallbacks of EN-DC Configurations

In 38.101-3 we find this general rule on fallbacks for EN-DC combinations:

*“A terminal which supports an inter-band EN-DC configuration with a certain UL configuration shall support the all lower order DL configurations of the lower order EN-DC combinations, which have this certain UL configuration and the fallbacks of this UL configuration. ”*

Of course this means that we have to support all fallbacks for which this rule is fulfilled.

This rule is a restriction of the general rule that all fallbacks need to be supported. The reason is that there can be combinations, for which the UL is not supported, of course when there is no UL, also the DL combination doesn’t make sense anymore.

- Assumption: DC\_1A-2A\_n3A is the DL configuration and DC\_1A\_n3A is supported as the UL.

*-* DC\_1A-2A\_n3A as DL configuration has DC\_1A\_n3A, DC\_2A\_n3A as next level fallbacks.

*-* The fallback DC\_1A\_n3A has the same UL DC\_1A\_n3A as the higher order combination, therefore this fallback is mandatory to be supported.

*-* The fallback DC\_2A\_n3A would need DC\_2A\_n3A as the UL, but only DC\_1A\_n3A is supported for the UL of the higher order combination, therefore this fallback is not mandatory to be supported.

Fallbacks from EN-DC to E-UTRA only or NR only configurations need to be supported as well. For example if we have a configuration DC\_1A-2A-3A\_n4A-n5A of course the constituent LTE combination CA\_1A-2A-3A as well as NR CA\_n4A-n5A need to be specified in 36.101 and 38.101 respectively and it is mandatory to support them, since the EN-DC combination is based on them.

### 4.3.4 Fallbacks of UL Configurations

Of course fallbacks of UL configurations need to be specified and supported as well.

– All fallbacks of UL configurations with higher order need to be supported down to a single carrier.

*-* Example: UL CA\_n265M needs these UL fallbacks: CA\_n265L, CA\_n265K, CA\_n265J, CA\_n265I, CA\_n265H, CA\_n265G, n265A.

*-* Example: UL EN-DC DC\_1A\_n265M needs these UL fallbacks: DC\_1A\_n265L, DC\_1A\_n265K, DC\_1A\_n265J, DC\_1A\_n265I, DC\_1A\_n265H, DC\_1A\_n265G, DC\_1A\_n265A.

Generally there is the rule that UL configurations can only have the same, or less carriers that are part of the DL configuration, as an example it is not allowed to have an UL configuration DC\_1A\_n265M for a DL configuration DC\_1A\_n265H.

### 4.3.5 Fallback rules for some exceptional cases

For some band combinations which include SDL bands (e.g. band n75) and/or only DL Scell bands (band combinations including band n7/7 and band n38/38 together), some fallback band combinations which can’t be deployed in reality can’t be considered as fallbacks.

For example:

– DC\_1A\_n75A-n78A: fallback is DC\_1A\_n78A. And DC\_1A\_n75A which can’t be deployed in reality can’t be considered as fallbacks. All fallbacks of UL configurations with higher order need to be supported down to a single carrier.

– DC\_1A-7A\_n38A-n78A: fallbacks are DC\_1A-7A\_n78A and DC\_1A\_n38A-n78A. DC\_1A-7A\_n38A and DC\_7A\_n38A-78A which can’t be deployed in reality can’t be considered as fallbacks.

– DL CA\_n1A-n7A-n38A: fallbacks are DL CA\_n1A-n7A and DL CA\_n1A-n38A. DL CA\_n7A-n38A which can’t be deployed in reality can’t be considered as fallbacks.

Generally, this special principle can be summarized as below. For a band combinations, if one RAT (LTE part or NR part) of this BC only include SDL band(s) and/or only DL Scell band(s), this BC which can’t be deployed in reality can’t be considered as fallbacks.

### 4.3.6 Guidelines on valid CBW for higher order BC depending on fallbacks

In current RAN4 specifications, for traditional BCS, some new CBWs such as 35MHz/45MHz were added in the higher order combinations but not yet introduced in the corresponding fallback lower order combinations. It results in the inconsistencies and leads some extra maintenance work to remove the CBWs in the higher order combinations that are missing in the lower fallbacks for traditional BCS. The following guidelines on valid CBW for new higher order BC request in traditional BCS from Rel-18 are to be supported. Note that for BCS4 and 5, the guideline does not apply.

– The per band supported channel bandwidths in a new higher order band combination from Rel-18 with traditional BCS should be a subset of or equal to channel bandwidths supported for the same band in at least one of the corresponding lower order band combination of the BCS.

– Band combination with the supported per channel bandwidths not meeting the above guidance should not be requested.

## 4.4 Submitting technical contributions (Tdoc) for specifying band combinations

### 4.4.1 Text Proposal (TP) or Draft Change Request (draft CR)

When providing technical contributions for the inclusion of a band combination there are two possible approaches.

1) Text Proposal (TP) to a Technical Report (TR) for the specific basket Work Item (WI).

2) Draft Change Request (draft CR) to the Technical Specification (TS)

RAN4 have agreed that if there is a need for any technical study/analysis as UE coexistence studies potentially resulting in relaxations needed defined this needs to be provided via a TP to a TR such that this study/analysis is captured in the TR. For new band combinations which does not require any technical study/analysis RAN4 has agreed to introduce these via draft CR directly to the TS. It shall be noted that not all the basket WIs have a TR indicating for which technical study/analysis may be needed and for which there is no need.

### 4.4.2 Specific for Text Proposal (TP)

TPs shall be drafted using the latest version of the corresponding TR as baseline and if included to the TR the provided template in the TR. All additions intended to be captured to the TR shall be marked with change-marks.

Sourcing company/companies are encouraged to combine all related band combinations to a single Tdoc for the TR containing one or more TPs with the needed technical analysis.

### 4.4.3 Specific for Draft Change Request (draft CR)

Draft CRs shall be drafted using the latest version of the corresponding TS as baseline. All additions intended to be captured to the TR shall be marked with change-marks.

Sourcing company/companies shall provide a single draft CR per basket WI corresponding to an individual agenda item at the RAN4 meetings. Noting that if a company is working with multiple other companies for providing technical input (draft CRs) for the same type of combinations (i.e. basket WI) each different group of sourcing companies shall be allowed to submit individual Tdocs. It shall also be noted that if different types of draftCRs are needed (e.g. Cat.B and Cat.F) a single draftCR per type is allowed.

### 4.4.4 Which agenda to submit the Tdoc for

The TP or draft CR shall be submitted to the agenda corresponding to the basket WI for which the specific band combination belongs (i.e.is included in the WID). Attention shall be made to which type of combinations it is under the basket if there are different sub-agendas for e.g. with or without FR2 parts of the combination.

# 5 Guidelines of specifying band combinations

## 5.1 General

The notation of the band combinations in the TS 38.101 specifications as well as the combination request lists by the operators and the basket WIDs can have significant impact, as it can become unclear what combination is really meant in the request or specification in cases of errors. Then the combination may be misinterpreted, not taken into account when implementing combinations in BS or UEs or even removed from specs or requests. Also automated processing of the tables will become difficult with too many bugs.

Generally, the notation of band combinations starts with the type of the configuration (mainly CA or DC), followed by one list (either LTE or NR) or two lists (first LTE, then NR) of bands with bandwidths. The following types of band combinations are defined in 3GPP specifications:

Carrier Aggregation: Starts with “CA\_” as the first three characters. Then either a list of LTE or NR carriers is following, where the carriers or bands are always separated by “-”. LTE and NR carriers cannot be combined, that would be a DC combination. Examples:

- CA\_1A-2A (LTE)

- CA\_n1A-n2A (NR)

- Examples for wrong notations: CA\_1A\_2A (“\_” instead of “-” between the carriers/bands), CA-1A-2A (no “\_” but “-” after “CA”, CA\_1A\_n2A (this would need to be a DC combination)

- NOTE: LTE examples are provided for information only

Dual Connectivity: Starts with “DC\_” as the first three characters, then for EN-DC configurations followed by the list of LTE carriers, a “\_” as separation between the LTE and NR carriers and then the list of NR carriers. For NE-DC configurations the list begins with NR carriers, a “\_” as separation between the NR and LTE carriers, and then the list of LTE carriers. There are exceptions for SUL EN-DC combinations, which separate the LTE and NR carriers by “\_SUL\_” instead of “\_”, and contiguous intra-band EN-DC combinations using “(n)” instead of “\_” and the “n” of the first NR band in the list. DC configurations within LTE or NR just list the carriers after “DC\_”., where the carriers are always separated by “-” For EN-DC combinations for V2X the “DC\_” at the beginning is replaced by “V2X\_”, even if it is still an EN-DC combination. Examples:

- DC\_1A\_n2A (EN-DC)

- DC\_1A-2A (LTE-DC)

- DC\_n1A-n2A (NR-DC)

- DC\_(n)1AA (EN-DC with contiguous intra-band LTE and NR carriers)

- DC\_1(n)AA (NE-DC with contiguous intra-band NR and LTE carriers)

- DC\_1A-(n)2AA (EN-DC with one LTE carrier followed by contiguous intra-band LTE and NR carriers)

- DC\_2(n)AA-1A (NE-DC with one LTE carrier followed by contiguous intra-band NR and LTE carriers)

- DC\_n78A\_1A-3A (NE-DC)

- Examples for wrong notations: DC\_1A-n2A (“-” instead of “\_” between the LTE and NR carriers/bands for EN-DC combinations), DC-1A-2A (no “\_” but “-” after “DC”, DC\_n1A\_n2A (“\_” instead of “-” between the NR carriers/bands for NR-DC combinations)

Supplementary UL: An NR SA configuration including one SUL carrier without CA is marked starting with “SUL\_” as the first four characters. If it is within an EN-DC combination there is a “\_SUL\_” between the LTE and the NR part instead of the “SUL\_” at the beginning, using the usual “DC\_” as the three characters. An NR SA configuration with CA including one SUL carrier is marked starting with “CA\_” as the first three characters. For intra-band CA with one SUL carrier, the list begins with intra-band CA, followed by “-” as separation, then the SUL carrier. For inter-band CA with one SUL carrier, the list begins with NR carriers without SUL, followed by “\_” as separation, then the NR carrier with SUL. For uplink EN-DC configuration, if TDM operation of uplink sharing from UE perspective (ULSUP) is chosen, the notation of “\_ULSUP-TDM\_” is used. The FDM operation of uplink sharing from UE perspective is not supported in current specifications. Examples:

- SUL\_n2A-n80A (n80 being the SUL band)

- CA\_n41C-n80A (n80 being the SUL band) : CA is between n41A and SUL\_n41A-n80A

- CA\_n78(2A)-n86A (n86 being the SUL band) : CA is between n78A and SUL\_n78A-n86A

- CA\_n1A\_n78A-n81A (n81 being the SUL band) : CA is between n1A and SUL\_n78A-n81A

- DC\_1A\_SUL\_n2A-n80A (n80 being the SUL band)

- DC\_3A\_n80A\_ULSUP-TDM\_n78A (TDM operation on SUL\_n78-n80)

In summary the following types and notations are defined:

- CA\_ …: A Carrier Aggregation configuration followed by the list of either LTE or NR carriers, or or NR carriers with one SUL carrier.

- DC\_ …: A Dual Connectivity configuration followed by the list of either LTE carriers for LTE-DC or NR carriers for NR-DC or for EN-DC first LTE carriers, then “\_” and the NR carriers or for NE-DC first NR carriers, then “\_” and the LTE carriers. In case of a DC combination for V2X, the “DC\_” is replaced with “V2X\_”.

- SUL\_ …: An NR SA configuration including one SUL carrier without CA. In case of a DC configuration with SUL, the “SUL\_” is shifted behind the “\_” separating the LTE and NR carriers and the configuration starts with “DC\_” as usual for DC configurations. In case of an uplink EN-DC configuration with SUL, “\_ULSUP-TDM\_” is applied for TDM operation for uplink sharing from UE perspective.

5.2 Notation of lists of bands and bandwidths within a configuration

### 5.2.1 Band numbers

A list of LTE or NR carriers within a CA or DC configuration is a either a single or multiple LTE or NR carriers. The simplest one is just a single carrier. It consists of the band number followed by the bandwidth class, which is “A” for a single carrier. For LTE the band number is just the number of the band, for NR carriers the numerical part of the band notation is preceded by an “n”, indicating this is a NR band, not a LTE band. NR bands above n256 are FR2 bands, below n256 are FR1 bands. The band number is always followed by the bandwidth class, which can be quite complicated for NR combinations with intra-band CA. Bandwidth classes other than “A” indicate multiple carriers in that band. In the list there can be multiple entries for inter-band CA configurations (in LTE also intra-band non-contiguous CA), which are always separated by “-”. The band numbers are sorted in increasing numbers. LTE and NR bands in the same frequency range usually have the same band number. Examples:

- Notation of a single LTE carrier: 1A, 2A, 3A etc.

- Notation of a single NR carrier: n1A, n2A, n3A etc.

- List of multiple LTE carriers on different bands: 1A-2A-3A.

- List of multiple NR carriers on different bands: n1A-n2A-n3A.

### 5.2.2 Bandwidth classes

#### 5.2.2.1 Bandwidth classes for LTE

An entry within the list of carriers always starts with the band number followed by the bandwidth class. In LTE the bandwidth classes (if not “A”) mean this is a contiguous CA configuration with multiple carriers. They are specified in table 5.6A-1 in 36.101 and can range from “A” for a single carrier up to F for 5 carriers. BW class I is specified for 8 carriers, but is not used. Non-contiguous CA combinations are just listing multiple sub-blocks separated by “-”. Examples:

- CA\_1B: Two contiguously aggregated LTE carriers with 20MHz or less in band 1.

- CA\_2F: Five contiguously aggregated LTE carriers with up to 100MHz in band 2.

- CA\_3A-3A: Two non-contiguously aggregated LTE carriers in band 3

- CA\_4A-4E: A single carrier followed by a gap and then followed by four contiguously aggregated carriers with up to 80MHz

- A single carrier is no CA configuration as there is nothing aggregated, so there is no CA\_5A, this is just 5A.

#### 5.2.2.2 Bandwidth classes for NR

NR bandwidth classes are much more complicated. Also here an entry within the list of carriers always starts with the band number followed by the bandwidth class. But in NR the bandwidth class includes contiguous and non-contiguous CA and a mixture of contiguous and non-contiguous CA. For contiguous CA the bandwidth classes are specified similar to LTE, but separate for FR1 and FR2. For FR1 contiguous CA BW classes are specified in table 5.3A.5-1 in 38.101-1 ranging from A to O (F is not used), in which the classes M, N and O are applicable for the use with shared spectrum channel access. For FR2 in 5.3A.4-1 in 38.101-2 ranging from A to W(N is not used), and R2 to R12, in which the classes V and W are applicable only for FR2-2 operating bands. The CA bandwidth classes for NR are categorized into different fallback groups (FBG). It is mandatory for a UE to be able to fallback to lower order NR CA bandwidth class configuration within a FBG, and not mandatory for a UE to be able to fallback to lower order NR CA bandwidth class configuration that belong to a different FBG.

A special kind or BW class specification is when there are intra-band contiguous LTE and NR carriers within an EN-DC combination like DC\_(n)1AA. In this case the LTE and NR carriers within that band are combined to a single entry of the list of carriers starting with (n) indicating that it can be “n” for the NR carrier, or no “n” for the LTE carrier. This is followed by the numerical value of the band (here “1”) and then the contiguous BW class for the LTE part and the contiguous BW class for the NR part. So DC\_(n)1AA means that there is a single carrier for LTE and a single carrier for NR side-by-side contiguously aggregated in band 1. This can be extended by more contiguous carriers on the LTE or NR side or both, for example DC\_(n)41DA means three contiguous carriers for LTE besides a single carrier for NR. This can be extended by other LTE carriers in front of the combination of carriers with (n) or with other NR carriers behind the (n) part, for example DC\_1A-(n)2AA or DC\_(n)2AA-n3A. The (n) part is considered as the last LTE combination in the list or the first NR combination in the list, therefore adding it with a “-” instead of a “\_”. For intra-band contiguous NE-DC configuration, instead of (n)X in EN-DC, the notation X(n) is used. In this case, DC\_X(n)yz indicates the contiguous NR Band carriers with channel bandwidth class y in Band nX is followed by the contiguous LTE carries with channel bandwidth z in Band X. For example, DC\_3(n)AA denotes the NE-DC combination of single carrier for NR in Band n3 and single carrier for LTE in Band 3.

However, the BW class part of a NR configuration also includes non-contiguous intra-band CA. For a combination containing any non-contiguous CA, i.e. a gap between any aggregated carriers, each block of single or contiguously aggregated carriers is called a sub-block, where a sub-block can also consist of the contiguously aggregated carriers as stated above. While in LTE single non-contiguously aggregated carriers are just duplicated like CA\_1A-1A, in NR the number of non-contiguous carriers of a BW class is counted and put in parenthesis with the number of sub-blocks of this type preceding the bandwidth class. Therefore a configuration with two non-contiguous carriers will have a BW class (2A) in NR, so the combination will be named CA\_n1(2A), meaning there are two non-contiguous carriers with BW class A in band n1.

However, there can also be the combination of contiguous and non-contiguous intra-band CA in NR. In. this case the sub-blocks of each BW class are separately counted and added within the brackets. For example if there are in a n260 FR2 CA combination two sub-blocks of BW class “A” (single carriers), three of BW class “G” (two contiguous carriers up to 100MHz) and one of BW class O (two carriers with 50 or 100MHz), the full combination will be named CA\_n260(2A-3G-Q), having 6 sub-blocks with in total 10 carriers. Examples:

- CA\_n1B: Two contiguously aggregated NR carriers with 100MHz or less in band n1 (FR1).

- CA\_n2D: Three contiguously aggregated NR carriers with up to 300MHz in band n2.

- CA\_n3(2A): Two non-contiguously aggregated NR carriers in band n3

- CA\_n260G: Two contiguously aggregated NR carriers with 150 or 200MHz in band n260 (FR2).

- CA\_n260M: Eight contiguously aggregated NR carriers with 750 or 800MHz in band n260 (FR2).

- CA\_n260(2A): Two non-contiguously aggregated NR carriers in band n260 with up to 800MHz (2x400MHz)

- CA\_n260(A-M): A single carrier followed by a gap and then followed by eight contiguously aggregated carriers with up to 100MHz each

- CA\_n260(2A-3G-Q): Two single carriers up to 400MNHz each, three sub-blocks with two carriers each of 150 or 200MHz per sub-block followed by another sub-block with two carriers of 50 or 100MHz each.

## 5.3 Rules to be used for the notation of CA or DC configurations

The following are the rules for generating the configuration notations:

- Each configuration needs to start with “CA\_”, “DC\_”, “SUL\_” or “V2X\_”.

- DC combinations include a list of LTE carriers first, followed by the list of NR carriers.

- Entries within a list of either LTE carriers or NR carriers need to be separated by “-”, not “\_”.

- The list of LTE carriers and the list of NR carriers within an EN\_DC combination need to be separated by “\_”, for contiguous intra-band EN-DC the two lists are connected with the (n)xxAA like notation, not “\_” (xx is the band number) , for contiguous intra-band NE-DC the two lists are connected with the xx(n)AA like notation, not “\_” (xx is the band number). In specific cases “\_SUL\_” connects the two lists.

- Contiguous LTE+NR intra-band carriers within a DC combination are using the notation (n)xxAA (xx is the band number) , Contiguous NR+LTE intra-band carriers within a DC combination are using the notation xx(n)AA (xx is the band number).

- No other characters than “A” to “Z”, “0” to “9”, “(“, “)”, “-”, “\_” and “n” are allowed within the notation, especially no spaces “ ”, “/”, “.”, LineFeed, CR, other special characters.

- Entries within the list of carriers need to be sorted in numerical order, i.e. first band n1, then n2, then n3, then n260, i.e. CA\_1A-2A, not CA\_2A-1A, but LTE and NR combinations are separately sorted, i.e. DC\_2A\_n1A, entries with (n) are always between the LTE and NR lists.

- Bandwidth notations are either a single character according to the BW class lists of contiguously aggregated carriers, two of these characters in case of combinations with (n) or for NR non-contiguous intra-band combinations specific expressions listing multiple carriers within “()”.

- Within the “()” of non-contiguous NR combinations there will only be BW class letters for the BW class of contiguous sub-blocks preceded by a number indicating the number of sub-blocks of this BW class, if there are multiple different BW classes they are listed in ascending BW class order separated by “-”.

Examples of correct notations are as follows:

- DC\_1A-2A\_n260(A-M)

- DC\_1A-2A-2A-2A\_n3(3A)

- DC\_1A-(n)2AA-n3A

- DC\_1A-2A-3A-4A-5A\_n6A-n260(2A-3G-Q)

- Some incorrect examples we have seen: DC\_1A-2A\_n3A(3A) (no “A” before the bracket); DC\_2A-1A\_n3(3A) (wrong sort order of LTE bands); DC\_1A- 2A\_n260(A-M) (a “ ” (space) between the “-“ and the “2”; DC\_1A-2A\_n260A/G/H/I/J/K/L/M (no “/” allowed within a configuration, multiple configurations not allowed within the notation, use separate configuration notations for each configuration).

Currently this notation for the CA/DC configurations is used as specified in 36.101 for LTE and 38.101 for NR. However, multiple errors within the specifications have been observed, which motivate the need to define the following rules how to handle the CA/DC configurations in the -101 specs. Below are the general rules how to implement these band combinations within the CA/DC configurations within the tables in clause 5.5:

- Each cell of the configuration table should contain only one combination of bands in the first column with the exception that combinations having the same bands but different intra-band contiguous BW classes can be listed in the same cell. Also all non-contiguous combinations can be listed in one cell, but separated from the contiguous combinations in another cell.

- In the UL column there shall only be UL configurations that belong to the configurations in the first column. Unfortunately this means that in the UL column there can be higher order configurations than some of the configurations in the first column, however, they cannot be used with such a lower order combination. This was agreed some time ago as a “table simplification”, but creates some hassle as there are UL combinations listed that cannot be supported with the DLs.

- Multiple configurations with different bandwidth classes shall be separated by pressing the return key, you will see the  sign at the end of the line if you activated the button to view these special characters, no other special characters to separate configuration shall be used.

- There shall be no special characters not belonging to the combinations in any configuration cell, no spaces “ ”, “/”, “.”, or any other special characters.

- If there are notes for a specific configuration, the note shall be using superscript font and added at the end of the configuration list within a cell, not anywhere within the configuration or separated with any other characters, multiple notes shall be separated just by a comma, all in superscript.

## 5.4 Guidelines on ΔTIB and ΔRIB

### 5.4.1 General

The ΔTIB and ΔRIB values are introduced to allow relaxation to the UEs transmit power (ΔTIB) and reference sensitivity (ΔRIB) to compensate for hardware complexity of supporting a given band combination.

### 5.4.2 2-band CA/DC ΔTIB,c and ΔRIB,c

To define ΔTIB and ΔRIB when introducing new 2-band CA/DC band combinations the following guidelines can be followed.

Grouping of bands:

* L-bands are below 1 GHz.
* H-bands are above 1 GHz and below 3GHz
* VH-bands are above 3 GHz

Delta values apply as follows for 2-band CA/DC:

* VH bands ΔTIB =0.8 and ΔRIB =0.5
* H bands ΔTIB =0.5 and ΔRIB =0
	+ Except for n1 and n3 which have ΔTIB =0.3
* H-L: Both gets ΔTIB =0.3 and ΔRIB =0
* L-L,H-H: Both gets ΔTIB =0.5 and ΔRIB =0
	+ Except for n1 and n3 which have ΔTIB =0.3
* L-VH: L ΔTIB =0.3 and ΔRIB =0.2
* H-VH: H ΔTIB =0.5 and ΔRIB =0.2
* Carriers with any uplink harmonic falling onto the DL:
	+ L-H: L ΔTIB =0.6 dB H ΔTIB =0.3 dB
	+ L-VH: L ΔTIB =0.6 dB VH ΔTIB =0.8 dB
	+ H-VH: H ΔTIB =0.6 dB VH ΔTIB =0.8 dB
* For SDL combinations SDL band gets “N/A” and L,H ΔTIB =0.3 and VH ΔTIB =0.8

### 5.4.3 More than 2-band CA/DC ΔTIB,c and ΔRIB,c

Delta values for more than 2-band CA/DC are found as the MAX of the included delta values defined for the next lower order CA/DC combinations. For example, the delta values for n-band CA/DC (n>2) are derived from the max delta values for (n-1)-band CA/DC.

### 5.4.4 Exceptions of ΔTIB and ΔRIB for specific band combinations

Due to multiple reasons the delta values captured together with the band combinations in the specifications may differ from the presented guidelines in Clause 5.4.2 and Clause 5.4.3. These values are found on a case-by-case basis when they are introduced.

### 5.4.5 Inclusion of ΔTIB and ΔRIB to the specification

Regarding to the tables for ΔTIB,c and ΔRIB,c, only the configurations having the same component E-UTRA / NR bands can be grouped into one cell (row). For example, in Table 5.4.5-1 for the ΔTIB,c of the inter-band EN-DC configurations, two rows should be specified separately in the table due to the different component bands {3, 7, 8, n1, n78} and {3, 7, n1, n8, n78}.

Table 5.4.5-1: Example for ΔTIB,c for Inter-band EN-DC configurations

| Inter-band EN-DC configuration | ΔTIB,c for E-UTRA band / NR band (dB)6 |
| --- | --- |
| Component band in order of bands in configuration7 |
| DC\_3-7-8\_n1-n78DC\_3-3-7-8\_n1-n78DC\_3-7-7-8\_n1-n78DC\_3-3-7-7-8\_n1-n78 | 0.6 | 0.6 | 0.6 | 0.6 | 0.8 |
| DC\_3-7\_n1-n8-n78DC\_3-3-7\_n1-n8-n78DC\_3-7-7\_n1-n8-n78DC\_3-3-7-7\_n1-n8-n78 | 0.6 | 0.6 | 0.6 | 0.6 | 0.8 |

It is supposed that only the configurations having the same component E-UTRA / NR bands can be grouped into one cell (row) for the ΔTIB,c and ΔRIB,c tables.

With regard to the values for a band combination in the ΔTIB,c / ΔRIB,c table, considering that a statement of ‘Unless otherwise stated, ΔTIB,c / ΔRIB,c is set to zero’ having been specified in the general part of specification, when all bands have values of ‘-’ (zero) it shall not be included to the specification tables. However, when proposing new band combinations via TPs, it should still be included to show the proposed values. For example in the following ΔRIB,c Table 5.4.5-2, the CA combinations CA\_n1-n3-n5, CA\_n1-n3-n18 and CA\_n1-n3-n20 do not need to be listed in the table.

Table 5.4.5-2: Example for ΔRIB,c for Inter-band CA configurations

|  |  |
| --- | --- |
| **Inter-band CA combination** | **ΔRIB,c for NR bands (dB)9** |
| **Component band in order of bands in configuration10** |
| ~~CA\_n1-n3-n5~~ | - | - | - |
| CA\_n1-n3-n8 | 0.2 | 0.2 | 0.5 |
| ~~CA\_n1-n3-n18~~ | - | - | - |
| ~~CA\_n1-n3-n20~~ | - | - | - |

For the band combination with all the component bands having the ΔTIB,c / ΔRIB,c values as ‘-’ (zero), there is no need to be listed in the ΔTIB,c / ΔRIB,c tables.

There are some special ΔTIB,c and ΔRIB,c values for the band combinations having SUL, SDL, immediately close component band, band combination with overlapping component band, and EN-DC combination with LTE LAA component band in the specifications. To avoid inconsistencies, the following guideline is applied to the band combinations having special component band.

- Non-zero value is not allowed for the special bands in the ΔTIB,c /ΔRIB,c tables.

- If uplink is not supported on a constituted band of the DC/CA band combination, "N/A" is used when deriving the ΔTIB,c requirements for that constituted band of the band combination.

- If downlink is not supported on a constituted band of the DC/CA band combination, "N/A" is used when deriving the ΔRIB,c requirements for that constituted band of the band combination.

## 5.5 Guidelines on MSD

### 5.5.1 Intra-band CA

#### 5.5.1.1 One Uplink CC

**Guidelines for intra-band reference sensitivity with one uplink carrier:**

1. It is sufficient to specify only one MSD test point per BCS.
2. If a test point can only be supported by a given BCS, a footnote is needed to indicate this restriction.

**Additionally,**

**For NR-CA intra-band contiguous reference sensitivity with one uplink CC**:

1. The MSD is specified for one DL SCC for which the reference sensitivity is increased by ΔRIBC.
2. For NR\_CA, the downlink PCC carrier center frequency shall be configured closer to the uplink operating band than any of the downlink SCC center frequency.
3. The PCC/SCC CBW and the UL band RB allocation are selected to specify the worst-case (highest) MSD level,
4. For UL RB allocation,
	1. The PCC UL band parameter “LCRB” is equal to the UL RB configuration specified in Table 7.3.2-3 Uplink configuration for reference sensitivity for the PCC DL channel bandwidth.
	2. The RBstart is specified to maximize the DL SCC overlap by the lowest IMD order.

**For NR-CA intra-band non-contiguous reference sensitivity with one uplink CC**:

1. The MSD is specified for one DL SCC for which the reference sensitivity is increased by ΔRIBNC.
2. Unless otherwise noted, the downlink SCC carrier center frequency shall be configured closer to the uplink operating band than the downlink PCC center frequency.
3. The PCC/SCC CBW and the UL band RB allocation are selected to specify the worst-case (highest) SCC MSD level, and the parameter “Wgap” is specified at the maximum value that can be configured to account for the DL band BW, PCC CBW and SCC CBW, i.e. Wgap = DL\_BandBW – (PCCCBW + SCCCBW).

**Guidelines for intra-band contiguous EN-DC reference sensitivity with one uplink carrier:**

For intra-band contiguous EN-DC within FR1 with one uplink CC:

1. Reference sensitivity requirements are verified with the downlink carrier(s) from the cell group without uplink configured closer to the uplink operating band than any of the downlink carriers from the cell group with uplink.
2. The UL/DL CBW and the UL band RB allocation are selected to specify the worst-case (highest) MSD level.

#### 5.5.1.2 Two Uplink CCs

### 5.5.2 Inter-band CA/DC

**Handling of MSD requirements related to optional or irregular channel bandwidth (CBW)**:

The following CBW shall not be considered as “valid new smallest CBW” when specifying the inter-band DL CA MSD requirements:

* 3MHz CBW, except when the DL affected band is Band n106,
* 7MHz CBW for all FR1 affected DL bands.

**Handling of MSD requirements for bands where the smallest DL CBW is restricted to Scell operation:**

As an exception, proponents may decide on a case-by-case basis if MSD requirements shall be or shall not be specified for bands where the smallest DL CBW is restricted to Scell operation.

For example, the Band n48 5MHz CBW MSD due to UL2/DL1 harmonic interference is specified for CA\_n25-n48, where band n48 5MHz CBW is restricted to Scell operation.

A counter example is the MSD of Band n40 due to UL2/DL3 harmonic mixing interference for CA\_n40-n77, where the band n40 MSD smallest DL CBW of 5MHz restricted to Scell operation is not specified. Instead, the band n40 MSD is specified for 10MHz CBW.

#### 5.5.2.1 Two-band Inter-band Downlink CA

5.5.2.1.1 One Uplink Band

5.5.2.1.1.1 One Uplink CC

Guideline on co-existence studies for harmonic interference and cross-band isolation:

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

Table 1**:** **UL/DL harmonics/harmonic mixing analysis.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **UL/DLharmonics** | **nX** | **UL12** | **UL2** | **UL33** | **UL4** | **UL5** | **MSD type** |
| **fLow** |  |  |  |  |  |
| **nY** | **fLow** | **fHigh** |  |  |  |  |  |
| **DL1** |  |  | N/A |  |  |  |  | **UL harmonic** |
| **DL23** |  |  |  | N/A |  | N/A | N/A | **Harmonic mixing** |
| **DL34** |  |  |  |  | N/A |  | N/A |
| **DL4** |  |  |  | N/A | N/A | N/A | N/A |
| **DL54** |  |  |  |  | N/A | N/A | N/A |
| **Analysis** | text |
| **UL/DLharmonics** | **nY** | **UL14** | **UL2** | **UL33** | **UL4** | **UL5** | **MSD type** |
| **fLow** |  |  |  |  |  |
| **nX** | **fLow** | **fHigh** |  |  |  |  |  |
| **DL1** |  |  | N/A |  |  |  |  | **UL harmonic** |
| **DL23** |  |  |  | N/A |  | N/A | N/A | **Harmonic mixing** |
| **DL34** |  |  |  |  | N/A |  | N/A |
| **DL4** |  |  |  | N/A | N/A | N/A | N/A |
| **DL54** |  |  |  |  | N/A | N/A | N/A |
| **Analysis** | text |
| Note 1: ULx means UL xth harmonic frequency, and DLy means DL yth harmonic frequency rangeNote 2: When a collision is detected with an overlap >0Hz between the ULx with DLy frequency ranges, the ULx/DLy cell is marked “D” for direct hit. When the gap between ULx and DLy frequency range is from 0Hz to x\*MinULCBW, the ULx/DLy cell is marked “N” for Near miss.Note 3: UL3/DL2 harmonic mixing direct hit case for PC3/5 only apply for DL>3GHzNote 4: For harmonic mixing, near-miss cases only apply for UL1 and odd DLy orders. |

Table 2 summarizes the frequency ranges where cross band isolation may occur for CA\_nX-nY.

Table 2 **Cross-band isolation** **analysis**

|  |  |  |
| --- | --- | --- |
| **Bands** | **nX** | **nY** |
| **Frequency limit** | **flow** | **fhigh** | **flow** | **fhigh** |
| **fUL (MHz)** |  |  |  |  |
| **fDL (MHz)** |  |  |  |  |
| **UL CBW (MHz)2** | Minimum CBW | Maximum CBW | Minimum CBW | Maximum CBW |
|  |  |  |  |
| **ACLR1 range** | fxULlow-maxULCBWx | fxULhigh+maxULCBWx | fyULlow-maxULCBWy | fyULhigh+maxULCBWy |
| **ACLR1 (MHz)** |  |  |  |  |
| **ACLR2 range** | fxULlow-2\*maxULCBWx | fxULhigh+2\*maxULCBWx | fyULlow-2\*maxULCBWy | fyULhigh+2\*maxULCBWy |
| **ACLR2 (MHz)** |  |  |  |  |
| **ACLR3 range** | fxULlow-3\*maxULCBWx | fxULhigh+3\*maxULCBWx | fyULlow-3\*maxULCBWy | fyULhigh+3\*maxULCBWy |
| **ACLR3 (MHz)** |  |  |  |  |
| **ACLR4 range** | fxULlow-4\*maxULCBWx | fxULhigh+4\*maxULCBWx | fyULlow-4\*maxULCBWy | fyULhigh+4\*maxULCBWy |
| **ACLR4 (MHz)** |  |  |  |  |
| **ACLR5 range1** | fxULlow-5\*maxULCBWx | fxULhigh+5\*maxULCBWx | fyULlow-5\*maxULCBWy | fyULhigh+5\*maxULCBWy |
| **ACLR5 (MHz)** |  |  |  |  |
| **Analysis** |  |  |
| NOTE 1: Even if there is no overlap up to ACLR5, MSD beyond the ACLR5 range should be evaluated further if:- The UL aggressor band and DL aggressor band are part of the same or adjacent band group as described in table 2a.1- If the DL band is above the UL band, it’s lower frequency edge must be below the UL lowest 2nd harmonic frequency- As an indicative threshold, if >45dB UL rejection at the DL band frequency can be guaranteed, assuming a -130dBm/Hz TX noise floor level, the transmitter noise floor related MSD should be negligibleNOTE 2: The maximum UL channel bandwidth of the BCS (noted maxULCBW) is used to calculate the band ACLR ranges while the minimum DL channel bandwidth of the BCS (noted minDLCBW) is used for the DL band victim channel bandwidth. |

**Table 2a.1: Band group definition for same or adjacent band-group criterion**

|  |
| --- |
| **FR1 band group range** |
| **Name** | **FR1-a** | **FR1-b** | **FR1-c** | **FR1-d** | **FR1-e** |
| **Range (MHz)** | 600-1000 | 1400-2200 | 2300-2700 | 3300-5000 | 5150-7125 |
| **Duplex mode** | Mostly FDD | Mostly FDD | FDD and TDD | TDD only | TDD only |

**Guidelines on handling new “greatest/smallest” CBW due to BCS4/5 [6] for MSD due to hamonic and cross-band isolation interference:**

Table 3 and Table 4 indicate cases in which the MSD test point ***must be re-visited***, and in cases where the MSD test point ***may be revisited*** on a case-by-case basis for:

* NR-CA combinations when a BCS4/5 request introduces a new greatest CBW or a new smallest CBW,
* EN-DC combinations when a new greatest CBW or a new smallest CBW is introduced in one of the constituent frequency band,
* Legacy BCS4/5 NR-CA combinations when a new greatest CBW or a new smallest CBW is introduced in one of the constituent frequency bands.

**Table 3**: Handling of MSD test points due to cross-band isolation interference

|  |  |  |
| --- | --- | --- |
|  | **New greatest CBW** | **New smallest CBW** |
| **UL band** | *MUST be revisited* | *May be revisited on case-by-case* |
| **DL band** | *May be revisited on case-by-case* | *MUST be revisited* |

**Table 4**: Handling of MSD due to harmonic interference (uplink and/or Rx harmonic mixing)

|  |  |  |
| --- | --- | --- |
|  | **New greatest CBW** | **New smallest CBW** |
| **UL band** | *May be revisited on case-by-case* | *May be revisited on case-by-case* |
| **DL band** | *May be revisited on case-by-case* | *MUST be revisited* |

It is recommended that proponents provide justification for cases where the MSD test point may need to be revisited.

**Handling of legacy UEs that may not support the new greatest/smallest CBW introduced by BCS4/5**:

For MSD test points due to harmonic interference and cross-band isolation interference:

1. To ensure that the conformance testing of legacy UEs is not impacted, the so-called “first MSD test point” remains unchanged, i.e., it remains the baseline mandatory MSD test point.
2. When the MSD test point must be or may be revisited on case-by-case basis, the new MSD test point becomes the second optional MSD test point in the current Release where BCS4/5 is introduced,
3. If the second optional test point is already specified, the revisited MSD test point replaces/overwrites the legacy agreed second optional test point.

**Guidelines for MSD Test Points due to direct-hit harmonic interference:**

These guidelines apply to both MSD due to UL harmonic interference and harmonic mixing interference except the victim NR DL band is either band n46, band n96 or band n102.

Guidelines for the DL band configuration:

1. For MSD due to direct-hit harmonic interference, a maximum of two test points can be specified:
* the first test point captures the smallest DL channel bandwidth (CBW) MSD,
* the second test point is optional and may capture the greatest DL channel bandwidth (CBW) MSD. For this second test point, other DL configurations are not precluded.
* The “smallest” and the “greatest” CBW shall not exceed the CBW specified in the BCS configuration tables of clause 5.5A.

Guidelines for the UL band configuration:

UL RB allocation:

1. The parameter “LCRB” is specified as follows for SCS 15kHz / SCS 30kHz respectively,
* For the UL2/DL1x test point, LCRB = 12RB / 6RB,
* For the UL3/DL1x test point, LCRB = 8RB / 4RB,
* For the UL4/DL1x test point, LCRB = 6RB / 4RB,
* For the UL5/DL1x test point, LCRB = 5RB / 2RB,
* For the harmonic mixing UL1/DLx test point, LCRB = 25RB / 12RB,

where x=1 for MSD due to UL harmonics, and where the valid “x” for MSD due to harmonic mixing is defined in Table 1.

UL band CBW:

1. The UL band is configured with the smallest UL CBW and the smallest SCS that can accommodate the specified UL LCRB,
2. The “smallest” and the “greatest” CBW shall not exceed the CBW specified in the BCS configuration tables of clause 5.5A.

**Guidelines for MSD Test Points due to near-miss uplink harmonic interference.**

1. Near-miss MSD test points are specified only for UL2/DL1 harmonic interference and only when the band combination does not meet the direct-hit criteria.
2. For near-miss MSD test points:
	1. Only one MSD requirement is specified for near-miss,
	2. The MSD is specified with:
		1. UL CBW = 5MHz,
		2. UL LCRB = 25RB (fully allocated),
		3. The Note 6 of Table 7.3A.4-1/ Note 6 of TS 38.101-3 Table 7.3B.2.3.1-1 is modified as follows:

NOTE 6: The near-miss requirements are only applicable when direct-hit requirements do not apply. These requirements should be verified for downlink channel bandwidths no larger than 10 MHz and with a carrier frequency at $\pm \left(10+BW\_{Channel}^{HB}/2\right)$ MHz offset from  in the victim (higher band) with , whereandare the channel bandwidths configured in the aggressor (lower) and victim (higher) bands in MHz, respectively.

**Guidelines for MSD Test Points due to cross-band isolation.**

Guidelines for the DL band configuration:

1. The affected DL band carrier centre-frequency shall be configured closest to the UL band.
2. A maximum of two test points can be specified:
* the first test point captures the smallest DL channel bandwidth (CBW) MSD,
* the second test point is optional and may capture the greatest DL channel bandwidth (CBW) MSD. For this second test point, other DL configurations are not precluded to account for say, regional spectrum allocations specificities, or proponent concerns on specific CBW of interest etc...

Guidelines for the UL band configuration:

* UL band CBW:
* For the so-called “first mandatory MSD test point”, the UL band shall be configured with the highest supported CBW across all specified BCSs. This ensures that the UL band smallest IMD order has a maximum reach towards the DL affected band.
* For the so-called “second optional MSD test point”, the UL band may be configured with an UL CBW other than the highest CBW supported across all specified BCSs.
* UL band carrier frequency and SCS:
* The UL band carrier centre frequency is configured closest to the affected DL band.
* The UL band SCS is specified for the lowest SCS that can be supported for the specified UL CBW.
* UL RB allocation:
* The parameter “LCRB” is that specified in Table 7.3.2-3 (UL configuration for UL Band REFSENS) for the corresponding UL band CBW.
* The parameter “RBSTART” is specified to ensure the UL RBs are positioned closest to the DL affected band.
* For SUL, the requirements are specified with the LCRB of the NR band counterpart as defined in Table 7.3.2-3 (UL configuration for UL Band REFSENS) for the specified SUL band CBW. A SUL-NR counterpart look-up is provided in **Table 5**.

Table 5: Handling SUL-NR counterpart lookup table

| **SUL band** | **NR UL Band counterpart** | **FUL\_low – FUL\_high (MHz)** |
| --- | --- | --- |
| n80 | n3 | 1710 – 1785 |
| n81 | n8 | 880 – 915 |
| n82 | n20 | 832 – 862  |
| n83 | n28 | 703 – 748 |
| n84 | n1 | 1920 – 1980 |
| n86 | n66 | 1710 – 1780 |
| n89 | n5 | 824 – 849 |
| n95 | n34 | 2010 – 2025 |
| n97 | n40 | 2300 – 2400 |
| n98 | n39 | 1880 – 1920 |
| n99 | n24 | 1626.5 – 1660.5 |

Guidelines on specifying the “source of interference”:

* The interference source can be either “ACLR1”, “ACLR2”, or greater than ACLR2 (“>ACLR2”).
* For “ACLR1”, or “ACLR2” test points:
	+ MSD may be neglected if the order of the IMD product of the modulated RB and its image that overlaps the affected DL band is greater than [9],
	+ For RB/Image IMD order less or equal to [7], the MSD needs to be analysed taking into consideration RF-FE complexity (quadplexer, triplexer, etc...),
* For “>ACLR2” test points, aka “flat-band noise cases” / large separation distances:
	+ MSD may need to be evaluated if the Tx noise rejection in the DL affected band is less than 45dB. The underlying assumption is that the flat Tx noise PSD is -130dBm/Hz and DL affected CBW is 5MHz.

5.5.2.1.1.2 Two UL CCs

For 2 band inter-band combinations with simultaneous Tx/Rx operation with at least 1UL band with intra-band UL CA in the UL configuration, MSD related to IMDs of intra-band UL CA part (contiguous or non-contiguous) needs to be analysed.

Guideline on co-existence studies for one UL band with 2CC intra-band UL CA:

Table 5.5.2.1.1.2-1 summarizes the frequency ranges where harmonics and/or harmonics mixing occur for CA\_ nX-nY.

**Table 5.5.2.1.1.2-1: Intra-band ULCA IMD overlap with the other DL band analysis.**

|  |  |  |  |
| --- | --- | --- | --- |
| **All in MHz** | **flow** | **fhigh** | **BB IMD range3** |
| **nX fUL** |  |  | **Order** | **flow** | **fhigh** |
| **nY fDL** |  |  |
| **2CCBW1** | Minimum  | Maximum  | **IMD2(1-1)** | Min2CCBW | Max2CCBW |
|  |  |  |  |
| **Close to UL IMD range2** | **IMD4(2-2)** | 2\*Min2CCBW | 2\*Max2CCBW |
| **Order** | **flow** | **fhigh** |  |  |
| **IMD3(2-1)** | fULlow-Max2CCBW | fULhigh+Max2CCBW | **IMD6(3-3)** | 3\*Min2CCBW | 3\*Max2CCBW |
|  |  |  |  |
| **IMD5(3-2)** | fULlow-2\*Max2CCLBW | fULhigh+2\*Max2CCBW | **Close to H2 IMD range4** |
|  |  | **Order** | **flow** | **fhigh** |
| **IMD7(4-3)** | fULlow-3\*Max2CCBW | fULhigh+3\*Max2CCBW | **IMD4(3-1)** | 2\*fULlow-Max2CCBW | 2\*fULhigh+Max2CCBW |
|  |  |  |  |
| **IMD9(5-4)** | fULlow-4\*Max2CCBW | fULhigh+4\*Max2CCBW | **IMD6(4-2)** | 2\*fULlow-2\*Max2CCBW | 2\*fULhigh+2\*Max2CCBW |
|  |  |  |  |
| **IMD11(6-5)** | fULlow-5\*Max2CCBW | fULhigh+5\*Max2CCBW | **Close to H3 IMD range4** |
|  |  | **Order** | **flow** | **fhigh** |
| **IMD13(7-6)** | fULlow-6\*Max2CCBW | fULhigh+6\*Max2CCBW | **IMD5(4-1)** | 3\*fULlow-Max2CCBW | 3\*fULhigh+Max2CCBW |
|  |  |  |  |
| **Analysis** | *Editor’s Note: The analysis conclusion for the UL CA IMD shall be included here, even if no issues are identified.*  |
| NOTE 1: 2CCBW is the instantaneous transmit bandwidth of the two intra-band UL CCs:- The minimum 2CCBW for contiguous / non-contiguous intra-band ULCA is 0 / minimum UL channel bandwidth- The maximum 2CCBW for contiguous / non-contiguous ULCA is Min(maximum aggregated bandwidth / maximum separation bandwidth(600MHz),fULhigh-fULlow)NOTE 2: The close to UL IMD range is the most critical when the victim DL band in proximity to the UL band:- For contiguous/non-contiguous intra-band ULCA within a TDD band, IMD order up to 9/7 should be considered and MPR assumed- For intra-band ULCA within a FDD band, IMD order up to 13 should be considered for bands in the same band group and MPR is not assumed. If justified by poor filtering performance, higher order IMD may need to be specified.NOTE 3: The BB IMD range should only be considered if the DL band is below the UL band and for non-contiguous ULCA within a TDD band >3GHz (assuming CA with 450MHz bands is not considered)- IMD2 is not considered assuming CA with 450MHz bands is not considered- IMD4 is considered for FDD or SimRx/Tx TDD bands <1GHz- IMD6 is considered for FDD or SimRx/Tx TDD bands <1.68GHzNOTE 4: The harmonic 2 and 3 IMD ranges should only be considered if the DL band is above the UL band |

Guidelines for IMD MSD test points

When the two UL CCs, a.k.a intra-band contiguous or non-contiguous CA configuration, is supported in the UL, it is mandatory to capture one test points, which is based on 1RB+1RB configuration. Optionally a full+full RB test point can be added. Both are based on the IMD order in table in section 7.3A.5 of TS 38.101-1used for the mandatory test point as long as some definition/explanation of the source of IMD is provided for the Full+Full case.

* The mandatory 1RB+1RB test point and optionally a full+full RB test points are captured in the current MSD table
* Include as a note for the optional full+full RB test points in IMD MSD table in the related band combination TP to TR and TS38.101-1.
* The IMD order captured in the table is the lowest IMD order of the two UL CCs that dominates the interfering power in the victim channel.
* This source of IMD are the same for the mandatory 1RB+1RB test point and the optional full+full RB test points.
* The optional full+full RB test point for the inter-band UL CA configurations with two contiguous CC in one band relies on the operator request.

Guidelines for IMD MSD order

If overlapping with the DL victim band, the lowest order IMD of each of the four IMD ranges (Close to UL IMD range, BB IMD range, close to H2 IMD range and close to H3 IMD range) is recommended as worst case to represent single band UL transmission with UL configured intra-band CA.

○ If applicable, a footnote shall be attached to the DL band to indicate that MSD may occur for higher order IMD products, and these orders shall be specified in the footnote.

○ A footnote shall be attached to the UL band that is configured intra-band UL CA to distinguish the case of intra-band contiguous vs intra-band non-contiguous CA.

Guidelines for general requirements assumptions:

If the UL configuration is contiguous UL CA, the following assumptions can be used:

IMD3 can reach up to 200MHz OOB with -13dBm/MHz.

IMD5 can reach up to 400MHz OOB with -30dBm/MHz for NS\_01 and -25dBm/MHz for NS\_04.

IMD7 can reach up to 600MHz OOB with -45dBm/MHz for NS\_01 and -35dBm/MHz for NS\_04.

If the UL configuration is non-contiguous UL CA, the following assumptions can be used:

IMD 3 can reach up to 600MHz OOB with -30dBm/MHz.

IMD 5 can reach up to 1200MHz OOB with -45dBm/MHz.

The above levels are further attenuated by the UL band filter and any diplexer and the higher order IMDs will decay further.

There is only an MSD or band protection issue with band that have simultaneous Tx/Rx with the UL band.

5.5.2.1.2 Two UL Bands

5.5.2.1.2.1 One UL CC in each band

Pre-Condition for dual UL MSD Analysis with 2UL CCs

For two-band inter-band combinations with 2UL CCs in two bands, i.e. 1UL CC in each band, the Pre-Condition for dual UL MSD Analysis with 2UL CCs are:

*○* Only FDD-FDD and TDD-FDD combination need to be considered.

Guideline on co-existence studies for one UL CC in each band

Table 5.5.2.1.2.1-1 lists Band nX + Band nY 2 bands UL CA(2CC) 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

**Table 5.5.2.1.2.1-1:** **Band nX and Band nY for 2CC 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 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. The lowest even order and lowest odd order IMD MSDs shall be considered. |

Guidelines for dual UL IMD MSD order

Up to IMD5 order need to be considered.

*○* If only one IMD order occurs per victim band, the MSD value shall be defined in the specifications.

*○* If the DL band may be affected by a mix of even and odd order IMD products, then the MSD value of the lowest even and the lowest odd order IMD, shall be defined in the specifications.

*•* When applicable, a footnote shall be attached to the DL band to indicate that MSD may occur for higher order IMD products, and these orders shall be specified in the footnote.

*○*  If the DL band may be affected only by multiple even order IMD products, or only by multiple odd order IMD products, then the MSD value of the lowest even order IMD or the MSD value of the lowest odd order IMD, shall be defined in the specifications.

*•* The lowest order IMD is recommended as worst case to represent the whole spectrum of the inter-band CA combinations.

*•* Optionally, a second MSD test point may be specified on a case-by-case basis to account for additional IMD orders. It is recommended this second MSD test point corresponds to the lowest even or the lowest odd order IMD.

*•* Any additional IMD order that is not specified shall be indicated by a note in the table.

Guidelines for dual UL IMD MSD test points

Dual UL MSD test points are captured in Reference Sensitivity exceptions due to intermodulation interference in clause 7.3A.5 in TS38.101-1 with the following parameters:

*○* FDD/TDD band Parameters

- DL Fc and UL Fc

- UL LCRB (i.e. full RB allocation)

- UL/DL BW (i.e. the supported smallest channel bandwidth for UL and DL each band)

- Duplex mode (i.e. FDD or TDD)

5.5.2.1.2.2 One UL CC in one band and two UL CCs in the other band

Pre-Condition for triple beat MSD Analysis with 3UL CCs

For two-band inter-band combinations with 3UL CCs in two bands, i.e. 1UL CC in one band, and 2UL CCs in the other UL band, the Pre-Condition for triple beat MSD Analysis with 3UL CCs are:

*○* Only FDD-FDD and TDD-FDD combination need to be considered with 3 uplink (UL) component carriers (CC) in two clusters within FR1.

*○* The 2 UL bands are part of the same band group or belong to adjacent band groups as defined in table 2a.1

Guideline on co-existence studies for one UL CC in each band

Table 5.5.2.1.2.2-1 lists Band nX + Band nY 2 bands UL CA(3CC) triple beat IMD analysis for Band nX- Band nY

**Table 5.5.2.1.2.2-1-1: Band nX and Band nY for 3CC UL IMD products**

|  |  |  |
| --- | --- | --- |
| **Band / CA1** | **nX** | **CA\_nYB/C** |
| **Frequency limit (all MHz)** | **fx\_low** | **fx\_high** | **fy\_low** | **fy\_high** |
| **fUL**  | – | – |
| **fDL** | – | N/A | N/A |
| **2CCBW2** | N/A | N/A | Minimum  | Maximum |
| – |
| **IMD3 products** | fxUL\_low-max2CCBW | fxUL\_low | fxUL\_high | fxUL\_high+max2CCBW |
| **IMD3 (MHz)** | – | – |
| **Analysis** | *Editor’s Note: The analysis conclusion for the 3UL CC IMD shall be included here, even if no issues are identified.* |
| NOTE 1: If the two bands are not part of the same or adjacent band groups as defined in table x.x.x, the analysis can be ignored.NOTE 2: For contiguous intra-band ULCA, the minimum and maximum separation BW are 0MHz and Min(fy\_high-fy\_low, maximum aggregated BW) respectively. |

Guidelines for triple beat IMD MSD order

*○* For the case when the victim band may be affected by a 1st order triple-beat product proponents should systematically check if the downlink band may be affected by dual uplink IMD3 interference. If the test point is missing, a dual UL IMD3 MSD test point should be specified.

*○* A 1st order triple beat product is a 3rd order non-linearity which may affect its own FDD DL band, and it should be captured as interference source "IMD3", see the calculation in table 5.5.2.1.2.2-1 above.

Guidelines for triple beat IMD MSD test points

Triple beat MSD test points are captured in Reference Sensitivity exceptions due to intermodulation interference due to 2UL CA (clause 7.3A.5 in TS38.101-1) with the following parameters:

*○* UL CA band (TDD or FDD) Parameters

- Must have non-contiguous RB allocation in UL LCRB (i.e. 1RB + 1RB)

- Duplex mode (ie. FDD or TDD)

- Spacing between RB allocations in each CC must equal the FDD Victim band duplex offset

- UL CC1 BW and UL CC1 Fc

- UL CC2 BW and UL CC2 Fc

*○* Non-UL CA FDD band Parameters

- DL Fc and UL Fc

- TX LCRB (i.e. full RB allocation)

- UL/DL BW (i.e. the supported smallest channel bandwidth for UL and DL each band)

- Duplex mode (i.e. FDD)

5.5.2.1.2.2 One UL CC in one band and two UL CCs in the other band

#### 5.5.2.2 Three-band DL CA/DC

5.5.2.2.1 Two UL Bands

5.5.2.2.1.0 General

For inter-band NR-CA or inter-band EN-DC 3DL/2UL MSD requirements due to dual UL IMD interference, the UL carrier frequency "UL Fc" and the UL RB allocation "UL LCRB" of the 3rd DL band which is affected by 2UL IMD interference shall be specified as "**N/A**".

These guidelines are illustrated in the examples of Table 5.5.2.2.1.0-1 and Table 5.5.2.2.1.0-2, including a special case of 3DL/2UL EN-DC combination with an intra-band EN-DC component, for example DC\_66A\_(n)5AA captured in Table 5.5.2.2.1.0-2.

**Table 5.5.2.2.1.0-1: Example of NR-CA 3DL/2UL MSD test points due to 2UL IMD interference**

|  |  |
| --- | --- |
| **Band / Channel bandwidth / NRB / Duplex mode** | **Source of IMD** |
| **NR CA band combination** | **NR band** | **UL Fc (MHz)** | **UL/DL BW (MHz)** | **UL****LCRB** | **DL Fc (MHz)** | **MSD (dB)** | **Duplex mode** |  |
| CA\_n1-n3-n28 | n1 | 1975 | 5 | 25 | 2165 | N/A | FDD | N/A |
|  | n3 | N/A | 5 | N/A | 1818.5 | 4.0 | FDD | IMD5 |
|  | n28 | 710.5 | 5 | 25 | 765.5 | N/A | FDD | N/A |
|  | n1 | N/A | 5 | N/A | 2139 | 11.0 | FDD | IMD4 |
|  | n3 | 1780 | 5 | 25 | 1875 | N/A | FDD | N/A |
|  | n28 | 710.5 | 5 | 25 | 765.5 | N/A | FDD | N/A |
| CA\_n1-n3-n41 | n1 | 1977.5 | 5 | 25 | 2167.5 | N/A | FDD | N/A |
|  | n3 | 1712.5 | 5 | 25 | 1807.5 | N/A | FDD | N/A |
|  | n41 | N/A | 10 | N/A | 2507.5 | 5.0 | TDD | IMD5 |

**Table 5.5.2.2.1.0-2: Example of EN-DC 3DL/2UL MSD test points due to 2UL IMD interference**

| **NR or E-UTRA Band / Channel bandwidth / NRB / MSD** |
| --- |
| **EN-DC Configuration** | **EUTRA / NR band** | **UL Fc (MHz)** | **UL/DL BW (MHz)** | **UL****LCRB** | **DL Fc (MHz)** | **MSD (dB)** | **IMD order** |
| DC\_1A-3A\_n28ADC\_1A-3C\_n28A | 1 | 1975 | 5 | 25 | 2165 | N/A | N/A |
|  | 3 | N/A | 5 | N/A | 1818.5 | 4.0 | IMD5 |
|  | n28 | 710.5 | 5 | 25 | 765.5 | N/A | N/A |
|  | 1 | N/A | 5 | N/A | 2139 | 11.0 | IMD4 |
|  | 3 | 1780 | 5 | 25 | 1875 | N/A | N/A |
|  | n28 | 710.5 | 5 | 25 | 765.5 | N/A | N/A |
| DC\_66A-(n)5AA | 5 | N/A | 5 | N/A | 878 | 25 | IMD2 |
|  | 66 | 1721 | 5 | 25 | 2121 | N/A | N/A |
|  | n5 | 838 | 5 | 25 | 883 | 30 | IMD2 |

5.5.2.2.1.1 One UL CC in each band

5.5.2.2.1.2 One UL CC in one band and two UL CCs in the other band

5.5.2.3 Guidelines on HPUE MSD Requirements Using Look-Up Tables

For MSD due to UL harmonics, harmonic mixing, or cross-band isolation interference, the 1UL band 1UL CC HPUE MSD requirements for inter-band two-band DL NR-CA, EN-DC, or SUL with DL CA can be calculated according to the eligibility criteria and the summary requirements of Table 5.5.2.3-1.

**Table 5.5.2.3-1: 1UL Band 1UL CC HPUE MSD Requirements Using Look-Up Tables for Inter-Band Two-Band DL NR CA, EN DC and SUL with Downlink CA.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Case / Eligibility / MSD requirements** | **NR-CA****TS 38.101-1** | **EN-DC****TS 38.101-3** | **SUL****TS 38.101-1** |
| **Case 1** | **Eligibility** | 1. **The PC3 MSD requirement is specified** in the following respective sub-clauses, ***and,***
2. **The PC2 and/or the PC1.5 MSD requirements are not specified**.
 | 7.3A.4, or 7.3A.6 | 7.3B.2.3.1, or 7.3B.2.3.2, or 7.3B.2.3.4 | 7.3C.2 |
| A valid 1UL PC21Tx, or PC22Tx, or PC1.52Tx configuration is specified in the following respective sub-clauses. | 5.5A.3.1 | 6.2B.1.3 or 6.2H.1.3 | 6.2.1 |
| Exclusion criteria: the following UL bands are not eligible. | n46, n96, n102 | B46, n46, n96, n102 | n/a |
| **HPUE MSD requirement****using Look-Up Tables** | HPUE MSD requirements | **PCx MSD = PC3 MSD + ΔMSD1** |
| Applicable HPUE power class “PCx” | PC21Tx, PC22Tx, or PC1.52Tx |
| ΔMSD requirements specified in the following respective Tables. | Table 7.3A.2.3.1-1 output columns denoted “ΔMSDmax 3, 6, 9”. | Table 7.3B.2.3.0.1-1 output columns denoted “ΔMSDmax 3, 6, 9”.  | Table 7.3C.2.1- output columns denoted “ΔMSDmax 3, 6, 9”.  |
| Correspondence between the specified ΔMSDmax and the source of interference and PCx is specified in the respective following tables. | Table 7.3A.2.3.1-2. | Table 7.3B.2.3.0.1-2. | Table 7.3C.2.1-2 |
| **Case 2** | **Eligibility** | 1. **The PC2 MSD requirement is specified** in the following respective sub-clauses, ***and,***
2. **The PC3 and the PC1.5 MSD requirements are not specified**.
 | 7.3A.4, or 7.3A.6 | 7.3B.2.3.1, or 7.3B.2.3.2, or 7.3B.2.3.4 | 7.3C.2 |
| A valid 1UL PC1.52Tx configuration is specified in the following respective sub-clauses. | 5.5A.3.1 | 6.2B.1.3 or 6.2H.1.3 | 6.2.1 |
| Exclusion criteria: the following UL bands are not eligible. | n46, n96, n102 | B46, n46, n96, n102 | n/a |
| **HPUE MSD requirement****using Look-Up Tables** | HPUE MSD requirements | **PC1.52Tx MSD = PC21Tx MSD + ΔMSD2** |
| ΔMSD requirements specified in the following respective Tables and the input column uses the specified “PC21Tx MSD” instead of “PC3 MSD”. | Table 7.3A.2.3.1-1 with output column denoted “ΔMSDmax 6”. | Table 7.3B.2.3.0.1-1 with output column denoted “ΔMSDmax 6”.  | Table 7.3C.2.1- output column denoted “ΔMSDmax 6”.  |
| Note 1: The PCx MSD requirements apply to the same uplink/downlink configurations as those specified for the minimum PC3 MSD requirements.Note 2: The PC1.52Tx MSD requirements apply to the same uplink/downlink configurations as those specified for the minimum PC2 MSD requirements. |

For MSD due to dual-UL interference, the 2UL band with 1UL CC per UL band HPUE MSD requirements for inter-band two-band or three-band DL NR CA or EN-DC can be calculated according to the eligibility criteria and the summary requirements of Table 5.5.2.3-2. In all cases, these MSD requirements do not apply to 2UL band EN-DC / NR CA configurations with 3UL CCs (e.g., a combination of intra-band and inter-band dual connectivity/carrier-aggregation).

**Table 5.5.2.3-2: 2UL Band with 1UL CC per UL Band HPUE MSD Requirements Using Look-Up Tables for Inter-Band Two-Band or Three-Band DL NR CA or EN DC.**

|  |  |  |
| --- | --- | --- |
| **Case / Eligibility / MSD requirements** | **NR-CA****TS 38.101-1** | **EN-DC****TS 38.101-3** |
| **Case 1** | **Eligibility** | 1. **The PC3 MSD requirement is specified** in the following respective sub-clauses, ***and,***
2. **The PC2 and/or the PC1.5 MSD requirements are not specified**.
 | 7.3A.5 | Table 7.3B.2.3.5.1, or Table 7.3B.2.3.5.2 |
| A valid two-band UL CA PC2 or PC1.5 configuration is specified for a total of 2Tx or 3Tx and 1CC in each UL band in the following respective sub-clauses. | 5.5A.3.1 or 5.5A.3.2 | 6.2B.1.3 or 6.2H.1.3 |
| Exclusion criteria: the following UL bands are not eligible. | n46, n96, n102 | B46, n46, n96, n102 |
| **HPUE MSD requirement****using Look-Up Tables** | HPUE MSD requirements | **PCx MSD = PC3 MSD + ΔMSD1** |
| Applicable HPUE power class “PCx” | PC2 or PC1.5 |
| ΔMSD requirements specified in the following respective Tables. | Table 7.3A.2.3.2-1 output columns denoted “ΔMSDmax 6, 9, 12, 15, 18, 24, 30”. | Table 7.3B.2.3.0.2-1 output columns denoted “ΔMSDmax 6, 9, 12, 15, 18, 24, 30”. |
| Correspondence between the specified ΔMSDmax and the IMD order and PCx is specified in the respective following tables. | Table 7.3A.2.3.2-2. | Table 7.3B.2.3.0.2-2. |
| **Case 2** | **Eligibility** | 1. **The PC2 MSD requirement is specified** in the following respective sub-clauses, ***and,***
2. **The PC3 and the PC1.5 MSD requirements are not specified**.
 | 7.3A.4, or 7.3A.6 | 7.3B.2.3.1, or 7.3B.2.3.2, or 7.3B.2.3.4 |
| A valid two-band UL CA PC2 or PC1.5 configuration is specified for a total of 2Tx or 3Tx and 1CC in each UL band in the following respective sub-clauses. | 5.5A.3.1 or 5.5A.3.2 | 6.2B.1.3 or 6.2H.1.3 |
| Exclusion criteria: the following UL bands are not eligible. | n46, n96, n102 | B46, n46, n96, n102 |
| **HPUE MSD requirement****using Look-Up Tables** | HPUE MSD requirements | **PC1.5 MSD = PC2 MSD + ΔMSD2** |
| ΔMSD requirements specified in the following respective Tables and the input column uses the specified “PC21Tx MSD” instead of “PC3 MSD”. | Table 7.3A.2.3.1-1 with output column denoted “ΔMSDmax 6,9,12,15”. | Table 7.3B.2.3.0.1-1 with output column denoted “ΔMSDmax 6,9,12,15”.  |
|  | Correspondence between the specified ΔMSDmax and the IMD order is specified in the respective following tables. | Table 7.3A.2.3.2-2: the IMD order is specified with column specified for “PC2 MSD”. | Table 7.3B.2.3.0.2-2: the IMD order is specified with column specified for “PC2 MSD”. |
| Note 1: The PCx MSD requirements apply to the same uplink/downlink configurations as those specified for the minimum PC3 MSD requirements.Note 2: The PC1.52Tx MSD requirements apply to the same uplink/downlink configurations as those specified for the minimum PC2 MSD requirements. |

## 5.6 Guidelines on MPR

TBD

## 5.7 Adding or removing channel BW’s in NR CA configurations

### 5.7.1 Adding channel BW’s in NR CA configurations

If it is discovered that it was forgotten to define a channel bandwidth when defining a band combination, the correct way is to define a new BCS row for that band combination. Such a definition of a new BCS follows the normally procedures of definitions of new BCS’s.

Preferably no exceptions should be made to the rule above. Exception can only be if all UE vendors can confirm that ...

a) no existing UE advertises the affected channel bandwidth (in the channel-BW bitmap) or the affected band combination (in the supportedBandCombinationList), or

b) all existing UEs that advertise the affected channel bandwidth and the band combination support and accept the configuration of that channel bandwidth in that BC.

The rule to follow by CR-authors and basket WI rapporteurs:

- If a channel bandwidth is added to an existing bandwidth combination set and if this channel bandwidth was already defined in Table 5.3.5-1 (“Channel bandwidths for each NR band”) in a previous version of the specification:

*- The change is non-backwards-compatible and needs to be documented on the CR cover page with the wording “*The addition of the channel bandwidth XXX to BCS#Y of band combination ABC is intentional and potential non-backwards compatible (NBC) impact have been considered.

### 5.7.2 Removing channel BW’s in NR CA configurations

#### 5.7.2.1 Removing of not possible channel BW’s

If it is discovered that a channel bandwidth in a band combination set is defined for a band that is not defined in Table 5.3.5-1 (“Channel bandwidths for each NR band”) it needs to be removed. Such a removal is not a non-backward compatible change. This is a correction of an inconsistency in the specification.

#### 5.7.2.2 Removing of possible channel BW’s

If it is discovered that a channel bandwidth was mistakenly included when defining the band combination, the correct way is to define a new BCS row in that band combination. Such a definition of a new BCS follows the normally procedures of definitions of new BCS’s.

Preferably no exceptions should be made to that rule. Exception can only be if all UE vendors can confirm that ...

a) no existing UE advertises the affected channel bandwidth (in the channel-BW bitmap) or the affected band combination (in the supportedBandCombinationList).

The rule to follow by CR-authors and basket WI rapporteurs:

- If a channel bandwidth is removed from an existing bandwidth combination set and if this channel bandwidth was already defined in Table 5.3.5-1 (“Channel bandwidths for each NR band”) in a previous version of the specification:

*- The change is non-backwards-compatible and needs to be documented on the CR cover page with the wording “*The removal of the channel bandwidth XXX to BCS#Y of band combination ABC is intentional and potential non-backwards compatible (NBC) impact have been considered.

### 5.7.3 Introduction of BCS4/BCS5

In NR band combination, it is a challenge for operators to request new NR CA and SUL band combinations when new channel bandwidths are added to existing bands in the band combinations. Operators have to go back and create new Bandwidth Combinations Sets for existing band combinations in order to be able to use those new channel bandwidths in NR CA and SUL. To reduce the workload in RAN4, a new WID for creating a new type of BCS was approved in [8].

BCS4/BCS5 are allowed to be applied to new band combinations in RAN4 which indicate UE to support up to all of the channel bandwidths for the band in the band combination. BCS4 is release independent to Rel-15 with no new signalling while BCS5 is functionally equivalent to BCS4 except that the new signalling [*supportedMinBandwidthDL/supportedMinBandwidthUL*] introduced in Rel-17 such as the limitation to the supporting channel bandwidth in each band within the band combination would apply, and BCS5 with the signalling [*supportedMinBandwidthDL/supportedMinBandwidthUL*] is allowed for early implementation from Rel-15. For a legacy gNB that was not upgraded to understand BCS4 or BCS5 with the new signalling, it would enable to ignore BCS4 or BCS5 with the new signalling.

Considering that BCSs are not defined or reported separately for UL and DL for traditional BCSs, there is also no need to differentiate BCS4/BCS5 for UL and DL. BCS4/BCS5 can be used for FR1 intra-band UL CA. Table 6.6.1-1 shows the template for NR CA configurations for intra-band contiguous CA with BCS4/BCS5. Table 6.6.1-2 shows the template for NR CA configurations for intra-band non-contiguous CA with BCS4/BCS5. For inter-band CA combinations including FR1 intra-band CA and with BCS4/BCS5, the bandwidth combination sets for the FR1 intra-band CA are BCS4/BCS5. The BCS4/BCS5 are represented in the inter-band CA configuration table by using the option which covers inter-band and intra-band as shown in Table 6.6.1-3. For SUL band combinations, BCS4/BCS5 reuse the same template with inter-band CA as in Table 6.6.1-3.

Table 5.7.3-1: Template for NR intra-band contiguous CA configurations with BCS4/BCS5

|  |
| --- |
| NR CA configuration / Bandwidth combination set |
| NR CA configuration | Uplink CA configurations | Channel bandwidths for carrier (MHz) | Channel bandwidths for carrier (MHz) | Channel bandwidths for carrier (MHz) | Channel bandwidths for carrier (MHz) | Channel bandwidths for carrier (MHz) | Maximum aggregated bandwidth (MHz) | Bandwidth combination set |
| CA\_nXC | CA\_nXC | 40 | 80, 100 |  |  |  | 180 | 0 |
| 50, 60, 80 | 60, 80, 100 |  |  |  |  |  |
| … | … |  |  |  | … | … |
|  |  | See nX channel bandwidths in Table 5.3.5-1 for each carrier2 |  |  |  | TBD | 4 and 5 |
| NOTE 1: 5 MHz is not applicable for 30/60 kHz SCS.NOTE 2: The aggregated bandwidth must be greater than or equal to the minimum for the bandwidth class defined in Table 5.3A.5-1, and smaller than or equal to the maximum aggregated bandwidth. |

Table 5.7.3-2: Template for NR intra-band non-contiguous CA configurations with BCS4/BCS5

|  |
| --- |
| NR CA configuration / Bandwidth combination set |
| NR CA configuration | Uplink CA configurations | Channel bandwidths for carrier (MHz) | Channel bandwidths for carrier (MHz) | Channel bandwidths for carrier (MHz) | Channel bandwidths for carrier (MHz) | Maximum aggregated bandwidth (MHz) | Bandwidth combination set |
| CA\_nX(2A) | CA\_nX(2A) | 40, 50, 60, 80,100 | 40, 50, 60, 80, 100 |  |  | 180 | 0 |
| … | … |  |  | … | … |
|  |  | See nX channel bandwidths in Table 5.3.5-1 for each carrier |  |  | TBD | 4 and 5 |

Table 5.7.3-3: Template for NR inter-band CA configurations including FR1 intra-band CA with BCS4/BCS5

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR CA configuration | Uplink CA configuration | NR Band | Channel bandwidth (MHz) | Bandwidth combination set |
|  |  |  | 5 | 10 | 15 | 20 | 25 | 30 | … | 100 |  |
| CA\_nXA-nYA | CA\_nXA-nYA | nX | 5 | 10 | 15 | 20 |  |  |  |  | 0 |
|  |  | nY | 5 | 10 | 15 | 20 | 25 | 30 |  |  |  |
|  |  | nX | See nX channel bandwidths in Table 5.3.5-1 | 4 and 5 |
|  |  | nY | See nY channel bandwidths in Table 5.3.5-1 |  |
| CA\_nXA-nYC | CA\_nXA-nYA | nX | 5 | 10 | 15 | 20 |  |  |  |  | 0 |
|  |  | nY | 5 | 10 | 15 | 20 | 25 | 30 |  |  |  |
|  |  | nX | See nX channel bandwidths in Table 5.3.5-1 | 4 and 5 |
|  |  | nY | See nY channel bandwidths in Table 5.5A.1-1 |  |

With regards to the applicability of BCS4/BCS5 to FR2 intra-band combinations, since all FR2 combinations only have BCS0 and new channel bandwidth have not been added, BCS4/BCS5 are probably not needed for FR2. For FR1+FR2 BCS4/BCS5 combinations the configuration table shall state that BCS0 applies for the intra-band FR2 part (when applicable).

#### 5.7.3.1 Guidelines for band combination with BCS4/BCS5

The following are the rules for applying BCS4/BCS5 for band combination request:

- BCS4/BCS5 apply to SUL, NR CA and SUL and/or NR CA part of inter-band MR-DC while it does not apply to intra-band MR DC.

- BCS4/ BCS5 shall be requested together, but BCS5 can’t be reported together with BCS4.

- For BCS4/BCS5 there is no need to add information in a BCS sheet about which channel bandwidths that are supported since there is no such details to be filled in for BCS4 and BCS5. For BCS4 and BCS5 it is enough just to fill in the band combination table sheet.

- If needed, traditional BCSs are allowed for all releases. For a new band combination in Rel-17 and onwards, if BCS4/BCS5 are requested, traditional BCSs are allowed pending on the proponents, the network of the proponents of BCS4/BCS5 is demanded to recognize BCS4/BCS5.

#### 5.7.3.2 The maximum aggregated bandwidth for intra-band CA with BCS4/BCS5

To guarantee the BCS4/BCS5 can cover all the possible bandwidth configurations for intra-band CA, the maximum aggregated bandwidth chosen for BCS4/BCS5 should equal to

- min{n\*max channel bandwidth of each carrier, BWChannel\_CA of each CA bandwidth class, Maximum frequency range of each band} for intra-band contiguous CA.

-min{n\*max channel bandwidth of each carrier, Maximum frequency range of each band - Minimum sub-block gaps} for intra-band non-contiguous CA.

where

- n is the number of aggregated CCs,

- minimum sub-block gaps indicates the sum of the min sub-block gap between the upper edge of lower component carrier and lower edge of higher component carrier that UE can support per band combination in two adjacent non-contiguous component carriers.

The value of min sub-block gaps could be clarified by the request operator but it should try to cover the needs of all possible operators.

## 5.8 Guidelines on drafting band combination tables

### 5.8.1 General on table notes draftings

The following are the rules for drafting table notes:

- For the existing notes in table in current spec, the notes should not be moved outside the table due to the issues of large number of “void” notes and external references to the notes outside of RAN4.

- For future notes in table,

1) Do not use NOTEs in tables for requirements that apply every cell/line or general requirements in the table. Use text above the table instead**.**

2) If similar notes are to be introduced into a table, a more generic note description should be considered.

3) If a note is intended for terminology, avoid having the note in the table if the terminology is defined in the clauses of symbols and abbreviations in the specification.

### 5.8.2 Guidelines on simplification for CA configurations

To avoid the redundancy and the explosive size of CA configuration table, the following guideline is proposed when drafting CA band combinations.

- There shall be no special characters such as “ ”, “,”, “.”, “/” or any other special character not belonging to the combinations with the exception that the delimiter “/” is allowed in the FR2 part of the uplink configurations. A note as below is suggested to be added at the end of the configuration tables.

Note: The delimiter “/” will only be used in the uplink configurations for the sake of simplicity. For example, CA\_nxA-nyA/B/C denotes CA\_nxA-nyA, CA\_nxA-nyB and CA\_nxA-nyC, where nx and ny are two NR bands, ny is a FR2 band and A, B and C are the corresponding bandwidth classes respectively.

### 5.8.3 Guidelines on grouping for DC configurations

In order to reduce the EN-DC, NE-DC and NR-DC configuration table size, the following guidelines should be applied to the grouping of the configurations.

- Grouping of DC configurations is based on *common band combination*.

- *Common band combination* is considered as the configuration having the same band sequence, such as DC\_x-y-y\_nz and DC\_x-x-y\_nz are not *common band combination*, while all configurations with DC\_x-y\_nz(\*) having non-contiguous parts in band nz are considered as *common band combination*.

- In case E-UTRA or/and NR has non-contiguous CA, it will be in a separate row compared to cases when DC configuration has only single carrier or contiguous CA operation.

- If multiple UL DC configurations are indicated with multiple DL DC configurations, only UL DC configurations with the same or a lower number of carriers in the same fallback group are valid UL configurations.

Annex A (informative):
Change history

|  |
| --- |
| **Change history** |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2024-10 | RAN4#112-bis | R4-2416422 | - | - | - | Initial version partly based on the technical report 38.846 V18.1.0 | 0.1.0 |
| 2024-11 | RAN4#113 | R4-2418328 | - | - | - | Implemented TP’s from RAN4#113:R4-2420473, TP to PRD01 on the maximum aggregated bandwidth for intra-band CA with BCS4/BCS5, CATTR4-2420472, TP for PRD 01 on table notes usage, ZTE | 0.2.0 |
| 2025-02 | RAN4#114 | R4-2501772 |  |  |  | Implemented TP’s from RAN4#114:[R4-2502974](http://10.10.10.10/ftp/RAN/RAN4/Inbox/R4-2502974.zip), TP for PRD 01 on delta TIB and RIB tables, ZTE Corporation, Sanechips[R4-2501643](file:///D%3A%5CRAN4%23114%5CDocs%5CR4-2501643.zip), TP for PRD 01 to include CA and DC simplification rules for configuration, ZTE Corporation, Sanechips[R4-2502975](http://10.10.10.10/ftp/RAN/RAN4/Inbox/R4-2502975.zip), TP to PRD01 for Guidelines on delta TIB and RIB, Nokia[R4-2503022](http://10.10.10.10/ftp/RAN/RAN4/Inbox/R4-2503022.zip), Input to RAN4 PRD on rules for 1UL CC MSD requirements, Skyworks Solutions Inc., Murata | 0.3.0 |
| 2025-08 | RAN4#116 | R4-2511177 |  |  |  | Implemented TP’s from RAN4#116:[R4-2512854](file:////Users/yangtang/Documents/work/RAN4/WG%20meetings/116/Docs/R4-2512854.zip), TP for PRD 01 to correct MSD test point for single UL band with one CC for two-band DL CA, ZTE Corporation, Sanechips[R4-2512855](file:////Users/yangtang/Documents/work/RAN4/WG%20meetings/116/Docs/R4-2512855.zip), TP for PRD 01 to IMD MSD test point for single UL band with two CCs for two band DL CA, ZTE Corporation, Sanechips[R4-2512856](file:////Users/yangtang/Documents/work/RAN4/WG%20meetings/116/Docs/R4-2512856.zip), TP for PRD 01 to IMD MSD test point with two UL band for two-band DL CA, ZTE Corporation, Sanechips[R4-2511208](file:////Users/yangtang/Documents/work/RAN4/WG%20meetings/116/Docs/R4-2511208.zip), TP to PRD 01 about status reports, EricssonR4-2512875, TP for PRD 01 to include guidelines on MSD for three bands DL CA and DC, ZTE Corporation, SanechipsR4-2512876, Update to PRD on handling optional CBW and cross-band isolation MSD, Skyworks Solutions Inc. | 0.4.0 |
| 2025-10 | RAN4#116-bis | R4-2514594 |  |  |  | Implemented TP’s from RAN4#116-bis:R4-2513752, TP for PRD 01 to correct guidelines for delta TIB and RIB for more than two bands combinations, ZTE Corporation, SanechipsR4-2514008, TP for PRD 01 to update band combination notation in clause 5.1, ZTE Corporation,SanechipsR4-2514009, TP for PRD 01 to correct BCS for NR DC, ZTE Corporation,SanechipsR4-2514552 TP for PRD 01 to introduce HPUE MSD requirements using look-up tables, Skyworks Solutions Inc. | 0.5.0 |