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| 3GPP TR 38.846 V18.0.0 (2023-12) | |
| Technical Report | |
| 3rd Generation Partnership Project;  Technical Specification Group Radio Access Network;  Study on simplification of band combination specification for NR and LTE  (Release 18) | |
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# Foreword

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

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

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

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

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

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

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

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

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

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

**should** indicates a recommendation to do something

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

**may** indicates permission to do something

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

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

**can** indicates that something is possible

**cannot** indicates that something is impossible

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

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

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

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

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

In addition:

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

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

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

# 1 Scope

The present document is a technical report for simplification of band combination specification for NR and LTE. The purpose of this TR is to further optimize and improve the working procedure for specifying band combination. A technical report will be created to collect the rules of band combination during the timescale of Rel-18 so as to improve the efficiency of band combination specifying and the quality of specifications. The dependency and applicability for RF requirements among different features for the same spectrum combination to reduce the redundant tests will also be investigated in the TR. The valid rules and valuable guidelines for requesting and specifying band combinations in Rel-17 TR 38.862 [7] are captured in the TR.

# 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 Background

At 3GPP RAN#96 meeting, a revised Rel-18 Study Item “Study on simplification of band combination specification for NR and LTE” was approved. The objectives are as follows,

- Investigate and simplify the working procedure for approving documents for TS and TR to improve the efficiency to specify band combinations and the quality of specifications

- Improve the efficiency considering

*-*  RAN4 reduces the redundant and unnecessary work for big CRs, draft CRs and/or TPs, if any

*-* The following rules will be investigated and defined if necessary

- Investigate whether the workflow can be improved under the condition that quality can be guaranteed.

*-* Develop rules or guidelines covering the process of not for block approval.

*-* Develop the necessary tools to reduce RAN4’s workloads if feasible

- Improve the quality considering

*--*RAN4 improves the procedures for cross-checking to avoid conflict between big CR/CRs across basket WIs and other WIs

– RAN4 captures the agreements about the rules and guidelines including but not being limited to the outcome of the above sub-bullets in the corresponding TR

Investigate the feasibility and optimize the specification structure and reduce the test burden

- Study the methodology to simplify the test efforts for a UE supporting multiple features, e.g., NR-CA, EN-DC on the same band combination

*-* Study of similarity and dependency of RF requirements for different features on the same band combination

- Study the methodology to simplify RF requirement specifications for

*-* MSD requirements in 38.101-1 and 38.101-3, e.g., reducing the test configurations with different bandwidth combinations

*-* For Delta\_TIB and Delta\_RIB requirements, investigate and define the framework of the general principle or requirements with band-combination specific exceptions

*-* For Delta\_TC,c, investigate whether it can be removed in low boundary formula for Pcmax

NOTE 1: The requirements applicable to UE won’t be changed or increased.

NOTE 2: The work should be applied to all the power classes

The target is that after the completion of the study item, the working procedure to specify the band combinations will be refined and the quality of specifications will be improved in the stage of Rel-18. A set of new guidance on band combination handling, rule collections and band combination optimization for RAN4 specifications will be approved. The feasibility to reduce the test burden of band combinations will be discussed. It is suggested that the rules related to the band combinations should be applied to the latest RAN4 specifications after the completion of the SI.

# 5 Working procedure of specifying band combinations

## 5.1 General

In order to make the band combinations work more efficient, RAN4 has decided to re-organize the corresponding basket WIs in Rel-18 with the following agreements.

|  |
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| –  *General:*  *○ To merge 1BUL and 2BUL basket WI for NR CA, i.e. merged into xBUL (x=1,2).*  *○ To establish one basket WI for SUL and one basket WI for V2X.*  *• NR\_SUL\_combos\_R18.*  *• NR\_LTE\_V2X\_PC5\_combos\_R18.*  *○ 2UL CA in FR1 + 1UL in FR2 can be treated in 2UL since we don’t need to count the number of FR2 UL.*  *○ There is no need to set a dedicated WI for non-block approval combos.*  – *Consider the following NR CA/DC band combination basket WIDs in Rel-18.*  *○ NR CA/DC*  *• NR\_CA\_R18\_intra including TR and TP’s.*  *• NR\_CADC\_R18\_2BDL\_xBUL (x=1,2) including TR and TP’s.*  *• NR\_CADC\_R18\_3BDL\_xBUL (x=1,2) including TR and TP’s.*  *• NR\_CADC\_R18\_yBDL\_xBUL (y=4,5,6, x=1,2) without TR and TP’s.*  *○ MR DC*  *• DC\_R18\_1BLTE\_1BNR\_2DL2UL.*  *• DC\_R18\_2BLTE\_1BNR\_3DL2UL.*  *• DC\_R18\_xBLTE\_1BNR\_yDL2UL (x= 3, 4, 5).*  *• DC\_R18\_xBLTE\_2BNR\_yDL2UL.*  *• DC\_R18\_xBLTE\_yBNR\_zDL2UL (x=1, 2, 3, y>2 , z≤6).*  *• DC\_R18\_xBLTE\_yBNR\_zDL3UL (x=1, 2, 3, 4, y=1, 2; 3≤z≤6).* |

Regarding to the simplification of working procedure, the following agreements have been achieved.

- The proponent of new BC request should be the first responsible person for checking the fallback BCs for a new BC request, and all companies are encouraged to check the fallbacks.

- With regard to the order of the request BC and its fallbacks, it is agreed that the higher order combination and its fallbacks request could be in parallel.

- For the deadline of BC request, same deadline as RAN4 Tdoc submission is supposed.

- No request of adding new band combinations into basket WIs will be handled for bis-meeting and ad-hoc meeting.

- No new band combination is allowed to be requested after the deadline.

- It is allowed to only correct the missing fallback and add more supporting companies for the proposed band combinations.

For V2X basket WI, the working procedure agreed in normal CA/DC basket WIs also be applied.

- To ensure the higher order combination not earlier than the lower order combinations in the spec, the following guidelines applied.

- Document the definition of fallback modes and the rules related to fallback mode in RAN4 TR.

- The big CRs for higher and lower order band combinations should be agreed in the same meeting.

- The rapporteurs do not have bland rows in the WID spreadsheets to facilitate the readers to sort out the interested band combinations.

## 5.1A Band combination request

### 5.1A.1 Band combination workflow

#### 5.1A.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 should 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.

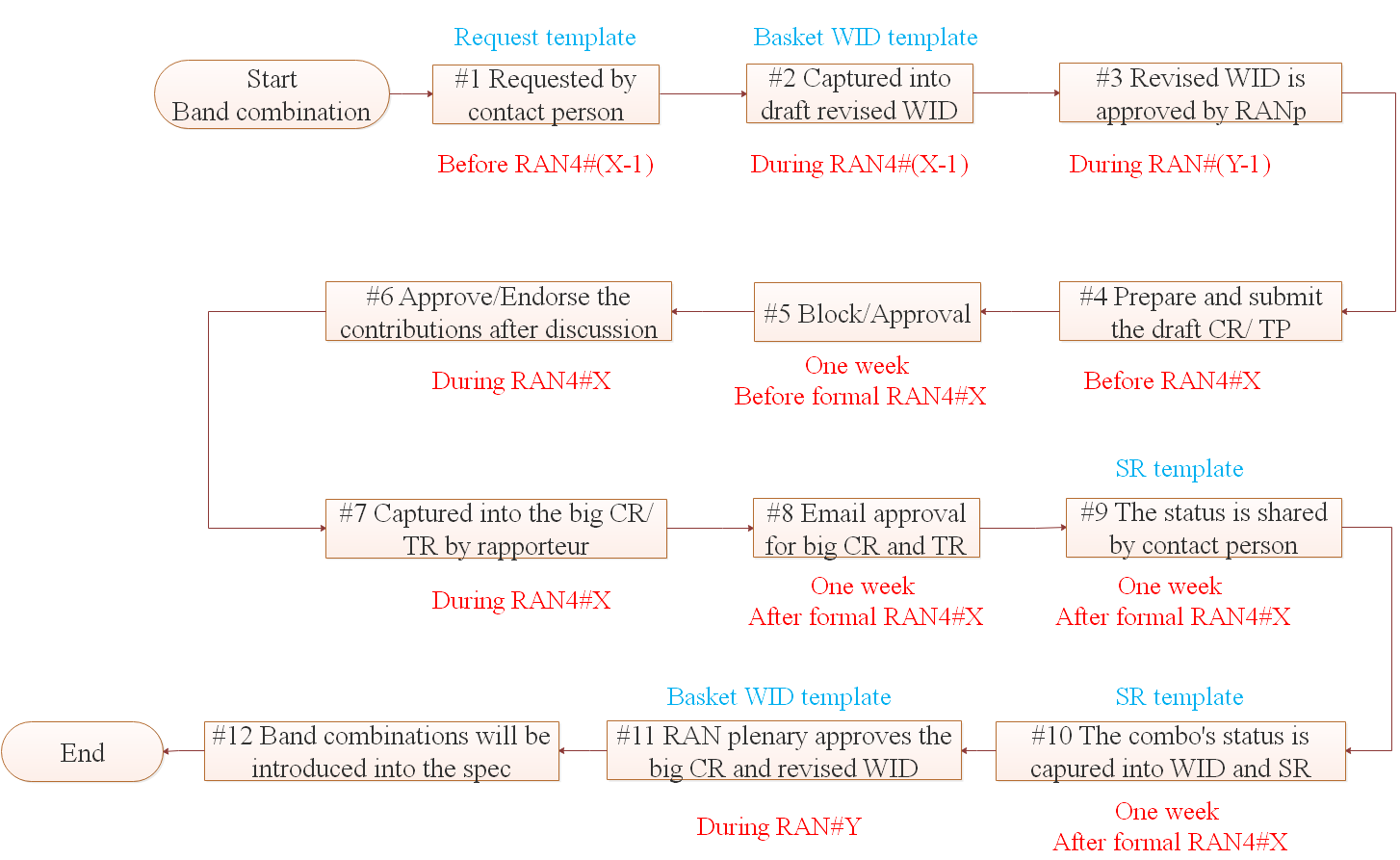


Figure 5.1A.1.1-1 The workflow on the introduction of band combinations for block approval

## 5.1B Usage of band combination

### 5.1B.1 Notation of CA or DC configurations in the 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.

## 5.2 New templates for specifying band combinations

### 5.2.1 Templates for PC3 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.

The R18 PC3 basket WID items were improved in RAN#96 meeting, including PC3 ENDC/NEDC, NR CA/DC, SUL and V2X basket WIDs, due to some of the R17 PC3 basket WID items are merged into one R18 PC3 basket WID, and also the table templates in the specification were changed during R17 discussion. Therefore, the original templates of band combination request sheet, status report and band combination table should be updated accordingly.

The updated EXCEL templates of band combination request sheet, status report and band combination table for Rel-18 PC3 band combinations can be found in the following 3GPP ftp server.

[*https://www.3gpp.org/ftp/tsg\_ran/WG4\_Radio/Templates/*](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/Templates/)

*(Editor’s note: The approved latest templates for PC3 band combinations are* *in R4-2307985)*

Besides the updated EXCEL templates, the other general rules captured in the section 6.2.2 in TR 38.862 [7] are still valid.

The update templates for PC3 NR CA, EN-DC, SUL and V2X band combinations in Rel-18 include the sheets for *‘Cover sheet’, ‘Band combination table’, ‘FR1 intra-band CA BCS table’, ‘FR2 intra-band CA BCS table’, ‘FR2 intra-band NCCA BCS table’, ‘Intra-band ENDC BCS table’, ‘FR1 inter-band BCS table’, ‘FR2 inter-band BCS table’, ‘FR1+FR2 inter-band BCS table’, ‘SUL band combination BCS table’, ‘V2X band combination BCS table’ and ‘FR1 Mixed intra-band CA BCS’:*

- Merging all the channel bandwidth columns into one column.

- Using ‘,’ between two adjacent channel bandwidths.

- Removing the channel bandwidth number in the table head.

– Only for inter-band NR CA) Using simple texts like ‘CA\_nXC\_BCS0’ or ‘CA\_nX(2A)\_BCS0’ for the constitute band supporting intra-band contiguous or non-contiguous CA , respectively, associated with a new note of “The CA configurations are given in Table 5.5A.1-1 or Table 5.5A.2-1 in this specification”.

### 5.2.2 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. The templates can be found in the following 3GPP ftp server and be applied to HPUE band combination request, revised WID and status report.

[*https://www.3gpp.org/ftp/tsg\_ran/WG4\_Radio/Templates/*](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/Templates/)

*(Editor’s note: The approved latest templates for HPUE band combinations are in R4-2306587)*

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.

The templates for HPUE band combination in Rel-18 include the sheets for ‘*Cover sheet*’, ‘*1.1&1.2\_BC table*’, ‘*1.3\_BC table with 2 SUL cells*’ and ‘*2\_BC table*’, in which the band combination list categorizes into:

– *1.1 Band combination list for Power class 2 NR Inter-band CA/DC for y bands DL with x bands UL (x=1, 2).*

*○ HPUE\_FR1\_TDD\_NR\_CADC\_SUL\_R18*

*○ Power class cases for uplink*

*• 1UL(TDD): PC2 on TDD band*

*• 2UL(FDD+TDD, TDD+FDD, TDD+TDD): PC3 on FDD band, PC2 or PC3 on TDD band*

– *1.2 Band combination list for Power class 1.5.*

*○ HPUE\_FR1\_TDD\_NR\_CADC\_SUL\_R18*

*○ Power class cases for uplink*

*• 1UL(TDD): PC1.5 on TDD band*

– *1.3 Band combination list for Power class 2 SUL band combinations with or without CA for y bands DL with 2 bands UL.*

*○ HPUE\_FR1\_TDD\_NR\_CADC\_SUL\_R18*

*○ Power class cases for uplink*

*• SUL: PC3 or PC2 on SUL band*

*• NUL(TDD): PC2 on TDD band, where NUL = Normal Uplink in contrast to SUL.*

– *2 Band combination list for High power UE (power class m with 1<m<3) for a single FR1 band in UL of Dual Connectivity (DC) combinations of x bands (x=1,2,3, 4 for y=1 or x=1, 2 for y=2) LTE inter-band CA (xDL/1UL) and y bands NR inter-band CA (yDL/1UL).*

*○ HPUE\_FR1\_DC\_LTE\_NR\_R18*

### 5.2.3 New templates of delta TIB / RIB due to NE-DC and SUL band combinations in Rel-18

For inter-band NE-DC within FR1, unless otherwise stated, the value of ΔTIB,c for the correspondingly specified EN-DC combination is applicable. However, for some specific NE-DC combinations, there are no corresponding EN-DC combinations defined in the spec. To unify the template as the cases in EN-DC combinations, the new delta TIB template in Table 5.2.3-1 and delta RIB template in Table 5.2.3-2 for NE-DC combinations applies respectively, two bands as an example.

Table 5.2.3-1: New template for ΔTIB,c due to NE-DC (two bands)

| Inter-band NE-DC configuration | **ΔTIB,c for NR band / E-UTRA band (dB)\*** | |
| --- | --- | --- |
| **Component band in order of bands in configuration\*\*** | |
| DC\_nx\_y |  |  |
| NOTE \*: “-” denotes ΔTIB,c = 0.  NOTE \*\*: The component band order in the configuration should be listed by the order of NR band and E-UTRA band respectively. | | |

Table 5.2.3-2: New template for ΔRIB,c due to NE-DC (two bands)

| Inter-band NE-DC configuration | **ΔRIB,c for NR band / E-UTRA band (dB)\*** | |
| --- | --- | --- |
| **Component band in order of bands in configuration\*\*** | |
| DC\_nx\_y |  |  |
| NOTE \*: “-” denotes ΔRIB,c = 0.  NOTE \*\*: The component band order in the configuration should be listed by the order of NR band and E-UTRA band respectively. | | |

For the UE which supports SUL band combination, the template for ΔTIB,c in Table 5.2.3-3 and ΔRIB,c in Table 5.2.3-4 applies respectively, three bands as an example.

Table 5.2.3-3: New template for ΔTIB,c due to SUL band combination (three bands)

|  |  |  |  |
| --- | --- | --- | --- |
| **Band combination for SUL** | **ΔTIB,c for NR bands / SUL band (dB)\*** | | |
| **Component band in order of bands in configuration\*\*** | | |
| CA\_nx\_SUL\_ny-nz |  |  |  |
| NOTE \*: “-” denotes ΔTIB,c = 0.  NOTE \*\*: The component band order in the configuration should be listed by the order of NR bands and SUL band, such as for CA\_n79\_SUL\_n41-n83 the band order from left to right is n41, n79 and n83. | | | |

Table 5.2.3-4: New template for ΔRIB,c due to SUL band combination (three bands)

|  |  |  |  |
| --- | --- | --- | --- |
| **Band combination for SUL** | **ΔRIB,c for NR bands / SUL band (dB)\*** | | |
| **Component band in order of bands in configuration\*\*** | | |
| CA\_nx\_SUL\_ny-nz |  |  |  |
| NOTE \*: “-” denotes ΔRIB,c = 0.  NOTE \*\*: The component band order in the configuration should be listed by the order of NR bands and SUL band, such as for CA\_n1\_SUL\_n78-n80 the band order from left to right is n1, n78 and n80. | | | |

### 5.2.4 New template for ΔTIB,c and ΔRIB,c tables for CA/DC

For the UE which supports CA/DC configurations, the allowed maximum configured output power relaxation has been set for the inter-band or SUL operation as ΔTIB,c. The allowed reference sensitivity relaxation has been set for the inter-band operation as ΔRIB,c. However, with the explosive growth of the number of combinations, the ΔTIB,c and ΔRIB,c tables in the specifications are seriously oversized and the readability is deteriorated. To optimize the tables of ΔTIB,c and ΔRIB,c, a new template in Table 5.2.4-1 and Table 5.2.4-2 is proposed in Rel-18 respectively.

Table 5.2.4-1: New template for ΔTIB,c tables in Rel-18

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Inter-band EN-DC configuration | ΔTIB,c for E-UTRA band / NR band (dB) | | | | |
| Component band in order of bands in configuration | | | | |
| DC\_1-3-7-40\_n78 | 0.6 | 0.6 | 0.5 | 0.3 | 0.8 |
| DC\_1-3-8-11\_n28 | 0.3 | 0.8 | 0.6 | 0.9 | 0.6 |
| … | … | … | … | … | … |
| Note 1: “-” denotes ΔTIB,c = 0.  Note 2: The component band order in the configuration should be listed by the order of E-UTRA band and NR band respectively, such as for DC\_2-48\_(n)5 the band order from left to right is 2, 5, 48 and n5. | | | | | |

Table 5.2.4-2: New template for ΔRIB,c tables in Rel-18

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Inter-band EN-DC configuration | ΔRIB,c for E-UTRA band / NR band (dB) | | | | |
| Component band in order of bands in configuration | | | | |
| DC\_1-3-7-40\_n78 | 0.2 | 0.2 | - | 0.4 | 0.5 |
| DC\_1-3-8-11\_n28 | - | 0.3 | 0.2 | 0.5 | 0.2 |
| … | … | … | … | … | … |
| Note 1: “-” denotes ΔRIB,c = 0.  Note 2: The component band order in the configuration should be listed by the order of E-UTRA band and NR band respectively, such as for DC\_2-48\_(n)5 the band order from left to right is 2, 5, 48 and n5. | | | | | |

## 5.3 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

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

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

The R18 PC3 basket WID items were improved in RAN#96 meeting, including PC3 ENDC/NEDC, NR CA/DC, SUL and V2X basket WIDs, due to some of the R17 PC3 basket WID items are merged into one R18 PC3 basket WID, and also the table templates 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.

### 5.4.2 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.

### 5.4.3 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.

### 5.4.4 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.

Exceptions for submitting to the agenda corresponding to the basket WI is agreed by RAN in WF [9] and listed below.

1) Intra-band CA or DC (intra-band UL related MSD or band protection)

2) 2 band inter-band CA or DC (intra-band UL CA IMD related MSD, LB-LB cases)

3) 3 band inter-band CA or DC (intra-band UL CA triple beat related MSD, LB-LB-LB cases)

In case of any of the exceptions above the TP or draft CR shall be submitted to the “not for block approval” agenda.

# 6 Guidelines of specifying band combinations

## 6.1 General

The notation of the band combinations in the 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\_”. 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: NR SA configurations start with “SUL\_” as the first four characters for SUL band combination with single carrier, as it is only NR without LTE, 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 first characters. 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. If SUL band combination with intra-band contiguous CA, intra-band non-contiguous CA or inter-band CA, the notation starts with “CA\_” as the first three characters. Examples:

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

- CA\_n41C-n80A (n80 being the SUL band)

- CA\_n78(2A)-n86A (n86 being the SUL band)

- CA\_n1A\_n78A-n81A (n81 being the SUL band)

- 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 SUL band combination with NR intra-band contiguous, non-contiguous or inter-band CA carriers.

- 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\_ …: A Carrier Aggregation configuration including one SUL band followed by a single NR carrier. 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.

## 6.1A Notation of lists of bands and bandwidths within a configuration

### 6.1A.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.

### 6.1A.2 Bandwidth classes

#### 6.1A.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.

#### 6.1A.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.

## 6.1B 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.

## 6.1C Adding or removing channel BW’s in NR CA configurations

### 6.1C.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.

### 6.1C.2 Removing channel BW’s in NR CA configurations

#### 6.1C.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.

#### 6.1C.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.

## 6.2 Guidelines on band combination fallbacks

### 6.2.1 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.

### 6.2.2 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 6.2.2-1: 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.

### 6.2.3 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.

### 6.2.4 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.

### 6.2.5 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.

### 6.2.6 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.

## 6.3 Guidelines on delta TIB and RIB due to band combinations

To optimize the tables of ΔTIB,c and ΔRIB,c due to band combinations, a new template for Rel-18 is proposed in clause 8.3.2 in TR 38.862.

Regarding to the optimized template for ΔTIB,c and ΔRIB,c tables, only the configurations having the same component E-UTRA / NR bands can be grouped into one cell (row). For example, in Table 6.3-1 for the ΔTIB,c of the following inter-band EN-DC configurations, since the component bands are not the same, two rows should be filled separately in the new template. However, for the configurations “DC\_3-7-8\_n1-n78”, “DC\_3-3-7-8\_n1-n78”, “DC\_3-7-7-8\_n1-n78” and “DC\_3-3-7-7-8\_n1-n78” having the same component bands, they should be merged into one cell.

Table 6.3-1: Example for ΔTIB,c for Inter-band EN-DC configurations

| Inter-band EN-DC configuration | E-UTRA or NR Band | ΔTIB,c (dB) |
| --- | --- | --- |
| DC\_3-7-8\_n1-n78  DC\_3-3-7-8\_n1-n78  DC\_3-7-7-8\_n1-n78  DC\_3-3-7-7-8\_n1-n78  DC\_3-7\_n1-n8-n78  DC\_3-3-7\_n1-n8-n78  DC\_3-7-7\_n1-n8-n78  DC\_3-3-7-7\_n1-n8-n78 | 3 | 0.6 |
|  | 7 | 0.6 |
|  | 8 or n8 | 0.6 |
|  | n1 | 0.6 |
|  | n78 | 0.8 |

| 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-n78  DC\_3-3-7-8\_n1-n78  DC\_3-7-7-8\_n1-n78  DC\_3-3-7-7-8\_n1-n78 | 0.6 | 0.6 | 0.6 | 0.6 | 0.8 |
| DC\_3-7\_n1-n8-n78  DC\_3-3-7\_n1-n8-n78  DC\_3-7-7\_n1-n8-n78  DC\_3-3-7-7\_n1-n8-n78 | 0.6 | 0.6 | 0.6 | 0.6 | 0.8 |

**Guideline 1: It is supposed that only the configurations having the same component E-UTRA / NR bands can be grouped into one cell (row) for the new ΔTIB,c and ΔRIB,c templates.**

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, it is reasonable to remove the combination in the ΔTIB,c / ΔRIB,c table with all component band having the value of ‘-’ (zero). For example in the following ΔRIB,c Table 6.3-2, 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 6.3-2: 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~~ | - | - | - |

**Guideline 2: 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 table.**

There are some special delta TIB and RIB 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 current specifications. However, the denotations for the delta TIB and RIB values for these special constituent band are inconsistent among different band combinations, some of which having the value of “-”, some of which having the value of “N/A”, while some of others having the value of non-zero number. To avoid inconsistencies, the following guideline is applied to the band combinations having special component band.

**Guideline 3: For the component bands which are special bands such as SDL band, SUL band, immediately close band, band combination with overlapping band, and EN-DC combination with LTE LAA band, etc.**

- Non-zero value is not allowed for the special bands in the delta TIB/RIB tables.

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

## 6.4 Guidelines on simplification for CA configurations

For CA configurations in the columns for DL and UL CA configurations, all the possible configurations are explicitly listed in the current CA configuration tables. However, the redundancy issue is becoming more and more serious in the CA configuration tables especially when multiple component frequency bands are involved. The permutation of component bands and CA BW classes results in explosive size of CA configuration table. In order to alleviate the workload for Rel-18 basket WID rapporteurs, the following guideline is proposed to CA configuration tables.

**Guideline 1: 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.

Table 6.4-1: Example for simplified inter-band CA configuration table

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NR CA configuration | Uplink configuration(\*) | NR Band | Channel bandwidth (MHz) (NOTE 1) | | Bandwidth combination set |
| CA\_n2A-n77A-n260A | CA\_n2A-n77A  CA\_n77A-n260A  CA\_n2A-n260A | n2 | 5, 10, 15, 20 | | 0 |
|  |  | n77 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 | |  |
|  |  | n260 | 50, 100, 200, 400 | |  |
| CA\_n2A-n77A-n260G | CA\_n2A-n77A  CA\_n2A-n260A/G  CA\_n77A-n260A/G | n2 | 5, 10, 15, 20 | | 0 |
|  |  | n77 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 | |  |
|  |  | n260 | CA\_n260G | |  |
| CA\_n2A-n77A-n260H | CA\_n2A-n77A  CA\_n2A-n260A/G/H  CA\_n77A-n260A/G/H | n2 | 5, 10, 15, 20 | | 0 |
|  |  | n77 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 | |  |
|  |  | n260 | CA\_n260H | |  |
| CA\_n2A-n77A-n260I | CA\_n2A-n77A  CA\_n2A-n260A/G/H/I  CA\_n77A-n260A/G/H/I | n2 | 5, 10, 15, 20 | | 0 |
|  |  | n77 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 | |  |
|  |  | n260 | CA\_n260I | |  |
| CA\_n2A-n77A-n260J | CA\_n2A-n77A  CA\_n2A-n260A/G/H/I/J  CA\_n77A-n260A/G/H/I/J | n2 | 5, 10, 15, 20 | 0 | |
|  |  | n77 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 |  | |
|  |  | n260 | CA\_n260J |  | |
| CA\_n2A-n77A-n260K | CA\_n2A-n77A  CA\_n2A-n260A/G/H/I/J/K  CA\_n77A-n260A/G/H/I/J/K | n2 | 5, 10, 15, 20 | 0 | |
|  |  | n77 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 |  | |
|  |  | n260 | CA\_n260K |  | |
| CA\_n2A-n77A-n260L | CA\_n2A-n77A  CA\_n2A-n260A/G/H/I/J/K/L  CA\_n77A-n260A/G/H/I/J/K/L | n2 | 5, 10, 15, 20 | 0 | |
|  |  | n77 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 |  | |
|  |  | n260 | CA\_n260L |  | |
| CA\_n2A-n77A-n260M | CA\_n2A-n77A  CA\_n2A-n260A/G/H/I/J/K/L/M  CA\_n77A-n260A/G/H/I/J/K/L/M | n2 | 5, 10, 15, 20 | 0 | |
|  |  | n77 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 |  | |
|  |  | n260 | CA\_n260M |  | |
| 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 class respectively. | | | | | |

## 6.5 Guidelines on Co-Existence analysis

### 6.5.1 Uplink Intra-Band CA with one UL CC transmissions

For harmonic mixing analysis where the UL of either band can directly or in the form of uplink harmonic interfere the DL receive band of the other band in the combination the following rules applies for the study of the combinations besides the frequency range checks. The rules are split into those of PC3 in Table 6.5.1-1 and those for PC2 or PC1.5 in Table 6.5.1-2. The cells in grey do not require harmonic mixing analysis. For certain UL/DL combinations an additional check on the DL frequency of the impacted receive band must be made.

Table 6.5.1-1: PC3 and PC5 harmonic mixing rules of analysis applicability

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PC3 and PC5 of UL band** | | | | |
|  | **UL1** | **UL2** | **UL3** | **UL4** |
| **DL2** | TBD | N/A | DL > 3GHz | N/A |
| **DL3** | All | All | N/A | TBD |
| **DL4** | TBD | N/A | DL > [3 or 5]GHz | N/A |
| **DL5** | All | TBD | N/A | N/A |

Table 6.5.1-2: PC2 and PC1.5 harmonic mixing rules of analysis applicability

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PC2 and PC1.5 of UL band** | | | | |
|  | **UL1** | **UL2** | **UL3** | **UL4** |
| **DL2** | TBD | N/A | All | N/A |
| **DL3** | All | All | N/A | TBD |
| **DL4** | All | N/A | DL > [3]GHz | N/A |
| **DL5** | All | TBD | N/A | N/A |

The TBD’s in tables 6.5.1-1 and 6.5.1-2 shall be further evaluated based on companies technical analysis during Rel-18.

### 6.5.2 Uplink Intra-Band CA with two UL CC transmissions

When adding a band combination including two uplink transmission in one UL Intra-Band Carrier Aggregation this study is needed for both non-contiguous and contiguous intra-band uplink CA.

There are 5 cases to consider where IMDs of the two CCs of an intra-band UL CA may cause MSD issues:

– FDD band with DL and UL contiguous intra-band CA (CA\_nXXB/ C UL and DL) => IMDs of intra band CA can cause MSD up to 7th order, only odd orders should be an issue.

– FDD band with DL and UL non-contiguous intra-band CA CA\_nXX(2A) UL and DL) => IMDs of intra band CA can cause MSD up to 7th order, only odd orders should be an issue.

– Two band simultaneous Rx/Tx combinations with 1 band UL with contiguous intra-band CA => IMDs of intra band CA can cause MSD up to 9th order, only odd order should be an issue as 2nd and 4th order are limited to 400MHz and higher even orders are typically low.

– Two band simultaneous Rx/Tx combinations with 1 band UL with non-contiguous intra-band CA => IMDs of intra band CA can cause MSD up to 7th order, 2nd order can be up to 600MHz and should not be an issue while 4th order can be an issue for low bands as it can reach up to 1200Mhz and higher even orders are typically low.

– Two band simultaneous Rx/Tx combinations with 2 band UL with contiguous intra-band CA in one of the bands => IMDs of intra band CA can cause MSD up to 7th order, 2nd order can be up to 600MHz and should not be an issue while 4th order can be an issue for low bands as it can reach up to 1200Mhz and higher even orders are typically low.

– The assumption that out of even order IMDs, only 4th order IMD is an issue, is based on the fact that in R18:

*-* Maximum UL aggregated BW for contiguous intra-band is 200MHz.

*-* Maximum bandwidth separation class is 600MHz.

– Two band simultaneous Rx/Tx combinations with 2 band UL with non-contiguous intra-band CA in one of the bands is not considered because it would require 3 non-contiguous UL clusters which is not allowed in R18.

Based on the above, an IMD calculation table can be made generic for all above cases as shown in Table 6.5.2-1.

Table 6.5.2-1: Co-existence studies for uplink configurations including intra-band UL CA

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Configuration | Channel  BW | Minimum  Channel  separation | Maximum  Instantaneous UL BW | Minimum  frequency | Maximum  frequency |  |
| Data |  |  |  |  |  | - |
| CC location | fU1L | fU2L | fU3L | fU1H | fU2H | fU3H |
| Frequency |  |  |  |  |  |  |
| 2nd | I fU1L-fU2L I | I fU1L-fU3L I | fU1L + fU2L | fU1H+fU2H | - | - |
| Interference ranges |  |  |  |  | - | - |
| 3rd | 2\*fU1L-fU3L | 2\*fU1H-fU3H | 2\*fU1L + fU2L | 2\*fU1H + fU2H | - | - |
| Interference ranges |  |  |  |  | - | - |
| 4th | I 2\*fU1L - 2\*fU2L I | I 2\*fU1H - 2\*fU3H I | 3\*fU1L - fU3L | 3\*fU1H - fU3H | 3\*fU1L + fU2L | 3\*fU1H + fU2H |
| Interference ranges |  |  |  |  |  |  |
| 5th | I 3\*fU1L-2\*fU3L I | I 3\*fU1H-2\*fU3H I | 4\*fU1L-fU3L | 4\*fU1H-fU3H | 4\*fU1L+fU2L | 4\*fU1H+fU2H |
| Interference ranges |  |  |  |  |  |  |
| 6th | I 3\*fU1L-3\*fU2L I | I 3\*fU1H-3\*fU3H I | 4\*fU1L-2\*fU3L | 4\*fU1H-2\*fU3H | 5\*fU1L-fU3L | 5\*fUH1-fU3H |
| Interference ranges |  |  |  |  |  |  |
| 7th | I 4\*fU1L-3\*fU3L I | I 4\*fU1H-3\*fU3H I | 5\*fU1L-2\*fU3L | 5\*fU1H-2\*fU3H | 6\*fU1L-fU3L | 6\*fU1H-fU3H |
| Interference ranges |  |  |  |  |  |  |
| 9th | I 5\*fU1L-4\*fU3L I | I 5\*fU1H-4\*fU3H I | 6\*fU1L-3\*fU3L | 6\*fU1H-3\*fU3H | 7\*fU1L-2\*fU3L | 7\*fU1H-2\*fU3H |
| Interference ranges |  |  |  |  |  |  |

If any issues are identified via the calculations presented in Table 6.5.2-1 additional REFSENS requirements may be needed.

In the Table 6.5.2-1 the following abbreviations is used:

fU1L = minimum frequency of TX aggressor band of ULCC1 lower band range (i.e. Minimum frequency edge of the band)

fU2L = minimum frequency of TX aggressor band of ULCC2 lower band range (i.e. Minimum frequency edge of the band)

fU3L = maximum frequency of TX aggressor band of ULCC2 lower band range (i.e. Minimum frequency edge of the band + Maximum Instantaneous UL BW)

fU1H = maximum frequency of TX aggressor band of ULCC1 higher band range (i.e. Maximum frequency edge of the band)

fU2H = minimum frequency of TX aggressor band of ULCC2 higher band range

fU3H = maximum frequency of TX aggressor band of ULCC2 higher band range (i.e. Minimum frequency edge of the band - Maximum Instantaneous UL BW)

fD1L = minimum frequency of RX victim band of DLCC placed on the lower frequency side of the TX aggressor band

fD1H = maximum frequency of RX victim band of DLCC placed on the lower frequency side of the TX aggressor band

fD2L = minimum frequency of RX victim band of DLCC placed on the higher frequency side of the TX aggressor band

fD2H = maximum frequency of RX victim band of DLCC placed on the higher frequency side of the TX aggressor band

Channel BW = Channel bandwidth of the component carrier.  
 - Equal to minimum UL CBW for non-contiguous UL CA  
 - Equal to the maximum UL CBW combination that fits the minimum between the maximum aggregated CBW for the BCS and the band bandwidth for contiguous UL CA

Minimum channel separation = Minimum frequency separation between the two component carriers or the inter CC GB  
 - Equal to 0 for contiguous intra-band UL CA  
 - Equal to minimum CBW for non-contiguous ULCA

Maximum channel separation = Maximum frequency separation between the two component carriers or aggregated uplink BW  
 - For contiguous intra-band UL CA it is equal to either the aggregated bandwidth or total bandwidth of the band, whatever is the smallest.  
 - For non-contiguous intra-band UL CA it is equal to either the bandwidth separation class bandwidth or total bandwidth of the band, whatever is the smallest.



Figure 6.5.2-1: Co-existence studies for Uplink Intra-Band Non-Contiguous CA

### 6.5.3 Uplink triple beat

When adding a band combination including three uplink transmission - one with UL intra-band carrier aggregation, which makes two tones and a third in the form of a single uplink component carrier this study is needed regardless if the intra-band CA is non-contiguous or contiguous intra-band uplink CA.

Table 6.5.3-1: Band nX and Band nY triple beat IMD products

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| CC location | fU1L | fU2L | fU3L | fU1H |  | CBW |
| Frequency | - | - | - | - |  | . |
| CC location | fSCCL | fSCCH | fU2H | fU3H |  | Min ch. separation |
| Frequency | - | - | - | - |  | - |
| 1st order TB | IfU3L -fU1L- fSCCL| | IfU2L -fU1L + fSCCL| | IfU2L -fU1L- fSCCH| | IfU3L -fU1L + fSCCH| |  | Max ch. separation |
| Ranges | - | - | - | - |  | - |
| 1st order TB | IfU2L+fU1L-fSCCH| | IfU1H+fU2H-fSCCL| | IfU2L +fU1L+fSCCL| | IfU1H +fU2H+fSCCH| |  |  |
| Ranges | - | - | - | - |  |  |

If any issues are identified via the calculations presented in Table 6.5.3-1 additional REFSENS requirements may be needed.

In the Table 6.5.3-1 the following abbreviations is used:

fU1L = minimum frequency of TX aggressor band of ULCC1 lower band range (i.e. Minimum frequency edge of the band)

fU2L = minimum frequency of TX aggressor band of ULCC2 lower band range (i.e. Minimum frequency edge of the band)

fU3L = maximum frequency of TX aggressor band of ULCC2 lower band range (i.e. Minimum frequency edge of the band + Maximum Instantaneous UL BW)

fU1H= maximum frequency of TX aggressor band of ULCC1 higher band range (i.e. Maximum frequency edge of the band)

fU2H= minimum frequency of TX aggressor band of ULCC2 higher band range

fU3H= maximum frequency of TX aggressor band of ULCC2 higher band range (i.e. Minimum frequency edge of the band - Maximum Instantaneous UL BW)

fSCCL = minimum frequency in single CC band

fSCCH = maximum frequency in single CC band

Channel BW = Channel bandwidth of the component carrier  
Minimum channel separation = Minimum frequency separation between the two component carriers or the inter CC GB  
Maximum channel separation = Maximum frequency separation between the two CCs or aggregated uplink BW  


Figure 6.5.3-1: Co-existence studies triple beat

For two-band inter-band CA or DC combinations, the precondition is that:

– The 2 UL bands are part of the same band group or belong to adjacent band groups as defined in Table 6.5.3-2.

For three-band inter-band CA or DC combinations and triple beat in third band, the precondition is that:

– The 3rd DL band belongs to the same band group or belongs to a band group which is adjacent to either one of the UL bands, where band groups are defined in Table 6.5.3-2.

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.

If the triple beat frequency is composed of the frequency sum of the 2 discrete RBs in the contiguous UL CA, there is no need to specify the TB test configuration as the requirement can already be verified by the fallback 2UL IMD3. The generic guidelines can be found in clause 7.4 for type 3 UL configurations.

Table 6.5.3-2: Band group definition for adjacent band-group criterion

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **FR1 band group range** | | | | | |
| **Name** | **FR1-1 (LB)** | **FR1-2 (MB)** | **FR1-3 (HB)** | **FR1-4 (VHB)** | **FR1-5 (UHB)** |
| 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 |

## 6.6 Rules for band combination with BCS4/BCS5

### 6.6.1 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 6.6.1-1: 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 6.6.1-2: 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 6.6.1-3: 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).

### 6.6.2 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, NR DC 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.

### 6.6.3 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.

## 6.7 Guidelines on simplification for 3DL/2UL MSD due to 2UL IMD interference

For inter-band NR-CA or inter-band EN-DC 3DL/2UL MSD requirements due to dual UL IMD interference, a maximum of two uplink configurations shall be specified: one uplink configuration in each band of the 2UL inter-band CA or DC configuration.

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 6.7-1 and Table 6.7-2, including the special case of 3DL/2UL EN-DC combination with only 2 frequency bands where one of the constituent bands is configured for intra-band CA operation, for example DC\_66A\_(n)5AA captured in Table 6.7-2.

**Table 6.7-1: Example of removing 3UL configurations for 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 |
|  | n28 | 710.5 | 5 | 25 | 765.5 | N/A | FDD | N/A |
|  | **n3** | **N/A** | 5 | **N/A** | 1818.5 | 4.0 | FDD | **IMD5** |
|  | n3 | 1780 | 5 | 25 | 1875 | N/A | FDD | N/A |
|  | n28 | 710.5 | 5 | 25 | 765.5 | N/A | FDD | N/A |
|  | **n1** | **N/A** | 5 | **N/A** | 2139 | 11.0 | FDD | **IMD4** |
| 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 6.7-2: Example of removing 3UL configurations for 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\_n28A  DC\_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 | 66 | 1721 | 5 | 25 | 2121 | N/A | N/A |
|  | **5** | **N/A** | 5 | **N/A** | 878 | 25 | **IMD2** |
|  | n5 | 838 | 5 | 25 | 883 | 30 | IMD2 |

## 6.8 Guidelines on configuration tables

### 6.8.1 CA configuration table

The CA configuration table in TS 38.101-1/-2/-3 provides the information of channel bandwidth, SCS and bandwidth combination set of the bands for each CA configuration. The uplink CA configuration information is also included in the configuration tables for the allowed UL CA configurations supported by the specification.

For inter-band CA configuration table, considering the huge number of configurations introduced into the spec, the guideline for the spec structure is as below:

- All combinations having the same number of constituent bands are categorized into one sub-clause, see Fig 6.8.1-1.

- For two bands inter-band CA configuration table in TS 38.101-1 5.5A.3.1, a “sub-table-group” tag is suggested to be applied for the purpose of easier retrieval, see Fig 6.8.1-2.

- For the other inter-band CA configuration tables which have huge configurations of more than 50 pages, the big table could be split to a limited number of up to three smaller sub-tables. The sub-tables should not have less than 40 pages and the maximum number should be 3 sub-tables after the split.

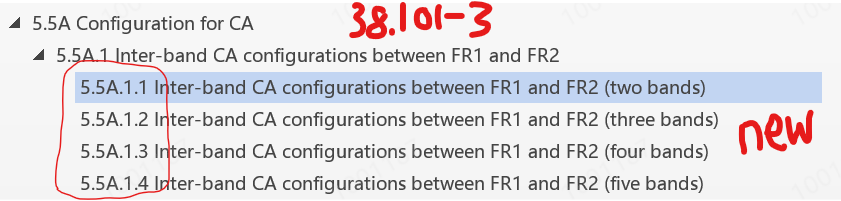


Figure 6.8.1-1 Example for sub-clauses for inter-band CA configurations

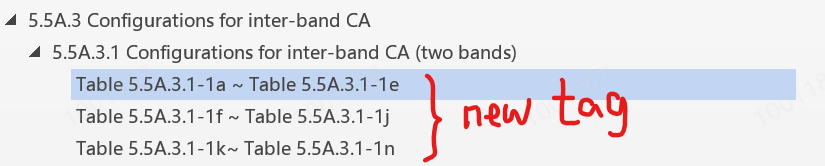


Figure 6.8.1-2 Example for “sub-table-group” tag for two bands inter-band CA configurations

For CA within FR1 bands, TS 38.101-1 [4] provides the CA configuration tables for intra-band contiguous CA, intra-band non-contiguous CA and inter-band CA for NR FR1 bands. The additional information for maximum aggregated bandwidth is set for intra-band contiguous and intra-band non-contiguous CA configuration tables for FR1.

For CA within FR2 bands, TS 38.101-2 [5] provides the CA configuration tables for intra-band contiguous CA, intra-band non-contiguous CA and inter-band CA for NR FR2 bands. The additional information for maximum aggregated bandwidth is set for intra-band contiguous and intra-band non-contiguous CA configuration tables in TS 38.101-2 [5]. For intra-band non-contiguous CA, the concept of sub-block is applied to FR2. Sub-blocks belonging to a CA configuration can be in any order. This means a certain CA configuration acronym includes all sub-block arrangements which have exactly the same sub-block set. As an example, CA\_n260(2G-3O) denotes CA\_n260(2O-2G-O), CA\_n260(G-3O-G) etc, but these are not listed in tables separately.

For CA between FR1 and FR2 bands, TS 38.101-3 [6] provides the inter-band CA configuration tables for NR bands between FR1 and FR2.

For the uplink CA configuration, “-” in the configuration table denotes that non-CA operation is supported in this configuration, i.e. only single carrier operation for the constituent band is used for uplink.

For the sake of brevity and to reduce the size of CA configuration tables, instead of showing explicitly in the CA configuration tables, the SCS info for each NR band in the configuration is referred to the channel bandwidths for each NR band in clause 5.3.5 of TS 38.101-1 [4] and TS 38.101-2 [5]. For configurations including intra-band contiguous part, the detail configuration for this part is referred to the corresponding intra-band contiguous CA configuration table. Examples:

For NR inter-band CA configuration with two bands in FR1, Table 6.8.1-1 illustrates that,

- CA\_n1A-n3A consists of two NR bands n1 and n3 whose SCS values are defined in Table 6.8.1-2. For example, for NR band n1, the supported channel bandwidth in BCS0 is 5MHz, 10MHz, 15MHz and 20MHz where channel bandwidth 5MHz supports SCS with only 15kHz, channel bandwidths 10MHz, 15MHz and 20MHz support all SCS of {15kHz, 30kHz, 60kHz}.

- CA\_n1B-n3A having intra-band contiguous part CA\_n1B, the configuration of band n1 for the corresponding CA part is referred to CA\_n1B\_BCS0 defined in intra-band contiguous CA configuration table.

- CA\_n2A-n66A consists of two BCSs. The UL CA configurations denote the allowed UL CA configurations supported by the specification. For BCS0, the uplink configuration “-” indicates that non-CA operation is supported and only single carrier operation is used in uplink. For BCS1, the uplink configuration supports CA configuration CA\_n2A-n66A.

- For some configurations, there are regional spectrum limitations to the corresponding bands and the notes can be found in the configuration table, such as for CA\_n2A-n48A\_BCS0, the channel bandwidths 50MHz, 60MHz, 80MHz, 90MHz and 100MHz are applicable only to downlink.

For channel bandwidth per operating band defined in clause 5.3.5 of TS 38.101-1/-2 and TS 38.104, Table 6.8.1-2 illustrates that,

- The requirements for each configuration should be complied with the combination of channel bandwidths, SCS for each operating band defined in the table.

- For some bands the limitations to the bandwidth may be captured with notes in the table, such as for NR band n48, the channel bandwidth 5MHz is restricted to operation when carrier is configured as an SCell part of DC or CA configuration.

Table 6.8.1-1: NR CA configurations and bandwidth combinations sets defined for inter-band CA (two bands)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR CA configuration | Uplink CA configuration or single uplink carrier10 | NR Band | Channel bandwidth (MHz) (NOTE 3) | Bandwidth combination set |
| CA\_n1A-n3A | CA\_n1A-n3A | n1 | 5, 10, 15, 20 | 0 |
|  |  | n3 | 5, 10, 15, 20, 25, 30 |  |
|  |  | n1 | 5, 10, 15, 20, 25, 30, 40, 50 | 1 |
|  |  | n3 | 5, 10, 15, 20, 25, 30, 40 |  |
|  |  | n1 | 5, 10, 15, 20 | 2 |
|  |  | n3 | 5, 10, 15, 20, 25, 30, 35, 40 |  |
|  |  | n1 | n1 channel bandwidths in Table 5.3.5-1 | 4 and 5 |
|  |  | n3 | n3 channel bandwidths in Table 5.3.5-1 |  |
| CA\_n1A-n3B | - | n1 | 5, 10, 15, 20 | 0 |
|  |  | n3 | CA\_n3B\_BCS0 |  |
| CA\_n1B-n3A | CA\_n1A-n3A | n1 | CA\_n1B\_BCS0 | 0 |
|  |  | n3 | 5, 10, 15, 20, 25, 30 |  |
|  |  | n1 | CA\_n1B\_BCS0 | 1 |
|  |  | n3 | 5, 10, 15, 20, 25, 30, 40 |  |
| … | … | … | … | … |
| CA\_n2A-n48A | CA\_n2A-n48A | n2 | 5, 10, 15, 20 | 0 |
|  |  | n48 | 5, 10, 15, 20, 40, 501, 601, 801, 901, 1001 |  |
|  |  | n2 | 5, 10, 15, 20 | 1 |
|  |  | n48 | 5, 10, 15, 20, 30, 40, 501, 601,701, 801, 901, 1001 |  |
| … | … | … | … | … |
| CA\_n2A-n66A | - | n2 | 5, 10, 15, 20 | 0 |
|  |  | n66 | 5, 10, 15, 20, 40 |  |
|  | CA\_n2A-n66A | n2 | 5, 10, 15, 20 | 1 |
|  |  | n66 | 5, 10, 15, 20, 25, 30, 40 |  |
| … | … | … | … | … |
| NOTE 1: This UE channel bandwidth is applicable only to downlink. | | | | |

Table 6.8.1-2: Channel bandwidths for each NR band

| NR Band | SCS (kHz) | UE Channel bandwidth (MHz) | | | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **5** | **10** | **15** | **20** | **25** | **30** | **35** | **40** | **45** | **50** | **60** | **70** | **80** | **90** | **100** |
| n1 | 15 | 5 | 10 | 15 | 20 | 25 | 30 |  | 40 | 45 | 50 |  |  |  |  |  |
|  | 30 |  | 10 | 15 | 20 | 25 | 30 |  | 40 | 45 | 50 |  |  |  |  |  |
|  | 60 |  | 10 | 15 | 20 | 25 | 30 |  | 40 | 45 | 50 |  |  |  |  |  |
| n2 | 15 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 |  |  |  |  |  |  |  |
|  | 30 |  | 10 | 15 | 20 | 25 | 30 | 35 | 40 |  |  |  |  |  |  |  |
|  | 60 |  | 10 | 15 | 20 | 25 | 30 | 35 | 40 |  |  |  |  |  |  |  |
| n3 | 15 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 |  |  |  |  |  |
|  | 30 |  | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 |  |  |  |  |  |
|  | 60 |  | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 |  |  |  |  |  |
| … | … | … | … | … | … | … | … | … | … | … | … | … | … | … | … | … |
| n41 | 15 | 54,11 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 |  |  |  |  |  |
|  | 30 |  | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 60 | 70 | 80 | 90 | 100 |
|  | 60 |  | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 60 | 70 | 80 | 90 | 100 |
| … | … | … | … | … | … | … | … | … | … | … | … | … | … | … | … | … |
| n48 | 15 | 55 | 10 | 15 | 20 |  | 30 |  | 40 |  | 506 |  |  |  |  |  |
|  | 30 |  | 10 | 15 | 20 |  | 30 |  | 40 |  | 506 | 606 | 706 | 806 | 906 | 1006 |
|  | 60 |  | 10 | 15 | 20 |  | 30 |  | 40 |  | 506 | 606 | 706 | 806 | 906 | 1006 |
| … | … | … | … | … | … | … | … | … | … | … | … | … | … | … | … | … |
| n66 | 15 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 |  |  |  |  |  |  |
|  | 30 |  | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 |  |  |  |  |  |  |
|  | 60 |  | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 |  |  |  |  |  |  |
| … | … | … | … | … | … | … | … | … | … | … | … | … | … | … | … | … |
| n78 | 15 |  | 10 | 15 | 20 | 25 | 30 |  | 40 |  | 50 |  |  |  |  |  |
|  | 30 |  | 10 | 15 | 20 | 25 | 30 |  | 40 |  | 50 | 60 | 70 | 80 | 90 | 100 |
|  | 60 |  | 10 | 15 | 20 | 25 | 30 |  | 40 |  | 50 | 60 | 70 | 80 | 90 | 100 |
| … | … | … | … | … | … | … | … | … | … | … | … | … | … | … | … | … |
| n80 | 15 | 5 | 10 | 15 | 20 | 25 | 30 |  | 40 |  |  |  |  |  |  |  |
|  | 30 |  | 10 | 15 | 20 | 25 | 30 |  | 40 |  |  |  |  |  |  |  |
|  | 60 |  | 10 | 15 | 20 | 25 | 30 |  | 40 |  |  |  |  |  |  |  |
| … | … | … | … | … | … | … | … | … | … | … | … | … | … | … | … | … |
| n86 | 15 | 5 | 10 | 15 | 20 |  |  |  | 40 |  |  |  |  |  |  |  |
|  | 30 |  | 10 | 15 | 20 |  |  |  | 40 |  |  |  |  |  |  |  |
|  | 60 |  | 10 | 15 | 20 |  |  |  | 40 |  |  |  |  |  |  |  |
| … | … | … | … | … | … | … | … | … | … | … | … | … | … | … | … | … |
| NOTE 1: Void.  NOTE 2: Void.  NOTE 3: This UE channel bandwidth is applicable only to downlink.  NOTE 4: This UE channel bandwidth is optional in this release of the specification.  NOTE 5: For this bandwidth, the minimum requirements are restricted to operation when carrier is configured as an SCell part of DC or CA configuration.  NOTE 6: For this bandwidth, the minimum requirements are restricted to operation when carrier is configured as a downlink SCell part of CA configuration.  NOTE 7: For the 20 MHz bandwidth, the minimum requirements are specified for NR UL carrier frequencies confined to either 713-723 MHz or 728-738 MHz. For the 25 MHz bandwidth, the minimum requirements are specified for NR UL carrier frequencies confined to either 715.5-720.5 MHz or 730.5-735.5 MHz. For the 30MHz bandwidth, the minimum requirements are specified for NR UL transmission bandwidth configuration confined to either 703-733 or 718-748 MHz.  NOTE 8: This UE channel bandwidth is applicable only to uplink.  NOTE 9: Void.  NOTE 10: For this band, UE channel bandwidths which are applicable to sidelink operation are specified in Table 5.3E.1-1.  NOTE 11: Not all frequency positions of 5 MHz carriers are possible due limitations of the SSB position relative to the 5 MHz channels. 5 MHz channels with Fc such that 2499+N\*1.2 ≤Fc<2499.3+N\*1.2MHz for 0≤N<157 are not compatible with SSB positions and cannot be used for 5 MHz n41.  NOTE 12: This UE channel Bandwidth is optional for uplink in this release of the specification. | | | | | | | | | | | | | | | | |

### 6.8.2 DC configuration table

NR-DC configurations within FR1 are specified in clause 5.5B of TS 38.101-1. In the configuration table, only NR-DC configurations and uplink NR-DC configurations are listed. The bandwidth combination sets for the corresponding inter-band CA, i.e., dual uplink inter-band carrier aggregation with uplink assigned to two NR bands, are applicable to Dual Connectivity.

EN-DC and NE-DC configurations are specified in clause 5.5B of TS 38.101-3. In the configuration table, in addition to the downlink configurations and uplink configurations, the combinations of intra-band contiguous, non-contiguous and inter-band within FR1 also include the column of “Single UL allowed”. The combination of some frequency bands in the configuration might be a bit problematic due to self-interference, as defined in TS38.306. UE may indicate capability of not supporting simultaneous dual and triple uplink operation due to possible intermodulation interference to its own primary downlink channel bandwidth if the intermodulation order is 2 or if the intermodulation order is 3 for the combinations when both operating bands are between 450 MHz – 960 MHz or between 1427 MHz – 2690 MHz. In case for the EN-DC configurations for which the intermodulation products caused by the dual and triple uplink operation fall into the receive band but do not interfere with the own primary downlink channel bandwidth as defined in Annex-I of TS 38.101-3 the UE is mandated to operate in dual and triple uplink mode. Single Uplink is also allowed for certain band combinations where intermodulation or reverse intermodulation products could create difficulty for meeting emission requirements. For EN-DC and NE-DC combinations of order 3 or higher, “Single Uplink allowed” UL configurations captured in the corresponding order 2 tables apply. As for an example, to mitigate the self-interference issue, the EN-DC configuration DC\_3A\_n78A has specified which band combinations are allowed to stray from the stringent requirement for simultaneous transmission and reception. The uplink needs to alternate between 1.8GHz and 3.5GHz. While 3.5GHz uplink transmission is ongoing, no data should be scheduled by the network on the 1.8GHz LTE carrier.

Apart from the above EN-DC and NE-DC configurations, TS 38.101-3 also specified inter-band NR-DC configuration between FR1 and FR2. The configurations and bandwidth combination sets for the FR1-FR2 NR-DC combinations are defined in the tables for FR1-FR2 inter-band carrier aggregation.

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

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

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

- Common band combination should be considered as the configurations having the same band sequence, such as DC\_x-y-y\_nz and DC\_x-x-y\_nz are different band combinations, while all configurations with DC\_x-y\_nz(\*) having non-contiguous parts in band nz are considered as common band combination.

*Examples* (*EN-DC with NR band having non-contiguous part*)*:*

|  |  |
| --- | --- |
| EN-DC  configuration | Uplink EN-DC  configuration |
| DC\_2A\_n258A  DC\_2A\_n258D  DC\_2A\_n258G  DC\_2A\_n258H  DC\_2A\_n258O  DC\_2A\_n258P  DC\_2A\_n258Q | DC\_2A\_n258A  DC\_2A\_n258D  DC\_2A\_n258G  DC\_2A\_n258H  DC\_2A\_n258O  DC\_2A\_n258P  DC\_2A\_n258Q |
| DC\_2A\_n258(2A)  DC\_2A\_n258(3A)  DC\_2A\_n258(4A)  DC\_2A\_n258(5A) | DC\_2A\_n258A |

*Examples* (*EN-DC with E-UTRA band having non-contiguous part*)*:*

|  |  |
| --- | --- |
| EN-DC  configuration | Uplink EN-DC  configuration |
| DC\_7A\_n257A  DC\_7A\_n257D  DC\_7A\_n257E  DC\_7A\_n257F  DC\_7A\_n257G  DC\_7A\_n257H  DC\_7A\_n257I  DC\_7A\_n257J  DC\_7A\_n257K  DC\_7A\_n257L  DC\_7A\_n257M | DC\_7A\_n257A  DC\_7A\_n257D  DC\_7A\_n257G  DC\_7A\_n257H  DC\_7A\_n257I |
| DC\_7A-7A\_n257A  DC\_7A-7A\_n257D  DC\_7A-7A\_n257E  DC\_7A-7A\_n257F  DC\_7A-7A\_n257G  DC\_7A-7A\_n257H  DC\_7A-7A\_n257I  DC\_7A-7A\_n257J  DC\_7A-7A\_n257K  DC\_7A-7A\_n257L  DC\_7A-7A\_n257M | DC\_7A\_n257A  DC\_7A\_n257D  DC\_7A\_n257G  DC\_7A\_n257H  DC\_7A\_n257I |

*Examples* (*NE-DC with E-UTRA band having non-contiguous part*)*:*

|  |  |
| --- | --- |
| NE-DC  configuration | Uplink NE-DC  configuration |
| DC\_n257A\_7A  DC\_n257G\_7A  DC\_n257H\_7A  DC\_n257I\_7A  DC\_n257J\_7A  DC\_n257K\_7A  DC\_n257L\_7A  DC\_n257M\_7A | DC\_n257A\_7A |
| DC\_n257A\_7A-7A  DC\_n257G\_7A-7A  DC\_n257H\_7A-7A  DC\_n257I\_7A-7A  DC\_n257J\_7A-7A  DC\_n257K\_7A-7A  DC\_n257L\_7A-7A  DC\_n257M\_7A-7A | DC\_n257A\_7A |

*Examples* (*NR-DC with NR band having non-contiguous part*)*:*

|  |  |
| --- | --- |
| NR-DC  configuration | Uplink NR-DC  configuration |
| DC\_n3A-n257A  DC\_n3A-n257D  DC\_n3A-n257G  DC\_n3A-n257H  DC\_n3A-n257I | DC\_n3A-n257A  DC\_n3A-n257D  DC\_n3A-n257G  DC\_n3A-n257H  DC\_n3A-n257I |
| DC\_n3(2A)-n257A  DC\_n3(2A)-n257G  DC\_n3(2A)-n257H  DC\_n3(2A)-n257I | DC\_n3A-n257A  DC\_n3A-n257G  DC\_n3A-n257I  DC\_n3A-n257H |

*Examples* (*Incorrect grouping case*)*:*

|  |  |
| --- | --- |
| EN-DC  configuration | Uplink EN-DC  configurationp |
| DC\_2A\_n261A  DC\_2A\_n261(2A)  DC\_2A\_n261(3A)  DC\_2A\_n261(4A) | DC\_2A\_n261A |
| DC\_2A\_n261B  DC\_2A\_n261C  DC\_2A\_n261D  DC\_2A\_n261E  DC\_2A\_n261F  DC\_2A\_n261G  DC\_2A\_n261H  DC\_2A\_n261I  DC\_2A\_n261J  DC\_2A\_n261K  DC\_2A\_n261L  DC\_2A\_n261M  DC\_2A\_n261O  DC\_2A\_n261P  DC\_2A\_n261Q | DC\_2A\_n261A  DC\_2A\_n261B  DC\_2A\_n261C  DC\_2A\_n261D  DC\_2A\_n261E  DC\_2A\_n261F  DC\_2A\_n261G  DC\_2A\_n261H  DC\_2A\_n261I  DC\_2A\_n261O  DC\_2A\_n261P  DC\_2A\_n261Q |

In this case, for DC\_2\_n261, the configurations with non-contiguous CA part CA\_n261(\*) such as DC\_2A\_n261(2A), DC\_2A\_n261(3A) and DC\_2A\_n261(4A) are mis-grouped with DC\_2A\_n261A which has only single carrier. They should be revised as follows.

|  |  |
| --- | --- |
| EN-DC  configuration | Uplink EN-DC  configuration |
| DC\_2A\_n261A  DC\_2A\_n261B  DC\_2A\_n261C  DC\_2A\_n261D  DC\_2A\_n261E  DC\_2A\_n261F  DC\_2A\_n261G  DC\_2A\_n261H  DC\_2A\_n261I  DC\_2A\_n261J  DC\_2A\_n261K  DC\_2A\_n261L  DC\_2A\_n261M  DC\_2A\_n261O  DC\_2A\_n261P  DC\_2A\_n261Q | DC\_2A\_n261A  DC\_2A\_n261B  DC\_2A\_n261C  DC\_2A\_n261D  DC\_2A\_n261E  DC\_2A\_n261F  DC\_2A\_n261G  DC\_2A\_n261H  DC\_2A\_n261I  DC\_2A\_n261O  DC\_2A\_n261P  DC\_2A\_n261Q |
| DC\_2A\_n261(2A)  DC\_2A\_n261(3A)  DC\_2A\_n261(4A) | DC\_2A\_n261A |

Regarding to the common band combination, it means the configurations having the same band sequence. For example, DC\_x-x-y\_nz and DC\_x-y-y\_nz are not considered as the common band combination.

*Examples* (*Incorrect understanding of common band combination*)*:*

|  |  |
| --- | --- |
| EN-DC configuration | Uplink EN-DC configuration |
| DC\_2A-66A\_n261A  DC\_2A-66A\_n261G  DC\_2A-66A\_n261H  DC\_2A-66A\_n261I  DC\_2A-66A\_n261J  DC\_2A-66A\_n261K  DC\_2A-66A\_n261L  DC\_2A-66A\_n261M | DC\_2A\_n261A  DC\_66A\_n261A  DC\_2A\_n261G  DC\_66A\_n261G  DC\_2A\_n261H  DC\_66A\_n261H  DC\_2A\_n261I  DC\_66A\_n261I |
| DC\_2A-2A-66A\_n261A  DC\_2A-2A-66A\_n261G  DC\_2A-2A-66A\_n261H  DC\_2A-2A-66A\_n261I  DC\_2A-2A-66A\_n261J  DC\_2A-2A-66A\_n261K  DC\_2A-2A-66A\_n261L  DC\_2A-2A-66A\_n261M  DC\_2A-66A-66A\_n261A  DC\_2A-66A-66A\_n261G  DC\_2A-66A-66A\_n261H  DC\_2A-66A-66A\_n261I  DC\_2A-66A-66A\_n261J  DC\_2A-66A-66A\_n261K  DC\_2A-66A-66A\_n261L  DC\_2A-66A-66A\_n261M | DC\_2A\_n261A  DC\_66A\_n261A  DC\_2A\_n261G  DC\_66A\_n261G  DC\_2A\_n261H  DC\_66A\_n261H  DC\_2A\_n261I  DC\_66A\_n261I |

In this case, the configurations DC\_2-66\_n261, DC\_2-2-66\_n261 and DC\_2-66-66\_n261 are not common band combinations. They should be re-grouped as follows.

|  |  |
| --- | --- |
| EN-DC configuration | Uplink EN-DC configuration |
| DC\_2A-66A\_n261A  DC\_2A-66A\_n261G  DC\_2A-66A\_n261H  DC\_2A-66A\_n261I  DC\_2A-66A\_n261J  DC\_2A-66A\_n261K  DC\_2A-66A\_n261L  DC\_2A-66A\_n261M | DC\_2A\_n261A  DC\_66A\_n261A  DC\_2A\_n261G  DC\_66A\_n261G  DC\_2A\_n261H  DC\_66A\_n261H  DC\_2A\_n261I  DC\_66A\_n261I |
| DC\_2A-2A-66A\_n261A  DC\_2A-2A-66A\_n261G  DC\_2A-2A-66A\_n261H  DC\_2A-2A-66A\_n261I  DC\_2A-2A-66A\_n261J  DC\_2A-2A-66A\_n261K  DC\_2A-2A-66A\_n261L  DC\_2A-2A-66A\_n261M | DC\_2A\_n261A  DC\_66A\_n261A  DC\_2A\_n261G  DC\_66A\_n261G  DC\_2A\_n261H  DC\_66A\_n261H  DC\_2A\_n261I  DC\_66A\_n261I |
| DC\_2A-66A-66A\_n261A  DC\_2A-66A-66A\_n261G  DC\_2A-66A-66A\_n261H  DC\_2A-66A-66A\_n261I  DC\_2A-66A-66A\_n261J  DC\_2A-66A-66A\_n261K  DC\_2A-66A-66A\_n261L  DC\_2A-66A-66A\_n261M | DC\_2A\_n261A  DC\_66A\_n261A  DC\_2A\_n261G  DC\_66A\_n261G  DC\_2A\_n261H  DC\_66A\_n261H  DC\_2A\_n261I  DC\_66A\_n261I |

For the uplink support in the configuration table, the valid uplink configurations are specified that uplink does not have more carriers than downlink. For the UL configuration type, it should be consistent within one row, i.e., there should not be a mixture of contiguous and non-contiguous UL CA within a row. 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.

*Examples:*

- DC\_5A\_n261G is not a valid uplink configuration for DC\_5A\_n261A.

- DC\_5A\_n261(2A) and DC\_5A\_n261A are not allowed to be in the same row in the configuration table.

For the sequence of EN-DC combinations, the following rules apply.

- EN-DC configurations should be sorted by LTE band combination, then NR band combination.

- LTE combinations should be sorted by the first band number, then the first bandwidth character, then the second band number, then the second bandwidth character and so on.

- The same sort order should be applied for the NR part, there combinations with () should be sorted alphanumerically within the brackets after the contiguous combinations.

For the sequence of NE-DC combinations, the following rules apply.

- NE-DC configurations should be sorted by NR band combination, then LTE band combination.

- NR combinations should be sorted by the first band number, then the first bandwidth character, then the second band number, then the second bandwidth character and so on. For the combinations with () should be sorted alphanumerically within the brackets after the contiguous combinations.

- LTE combinations should be sorted by the first band number, then the first bandwidth character, then the second band number, then the second bandwidth character and so on.

For the sequence of NR-DC combinations, the following rules apply.

- DC combinations should be sorted by the first band number, then the first bandwidth character, then the second band number, then the second bandwidth character and so on.

- For the combinations with () should be sorted alphanumerically within the brackets after the contiguous combinations.

*Examples:*

- DC\_1A\_n77A

- DC\_1A\_n77C

- DC\_1C\_n77A

- DC\_1C-2A\_n77A

- DC\_41A-42A\_n79A

- DC\_41A-42C\_n79A

- DC\_41C-42A\_n79A

- DC\_41C-42C\_n79A

- DC\_41C-42C\_n257A

- DC\_41C-42C\_n257M

- DC\_41C-42C\_n257(2A)

- DC\_41C-42C\_n257(2A-2O)

- DC\_41C-42C\_n257(8A)

- DC\_41C-42C\_n257(D-G)

### 6.8.3 SUL configuration table

The SUL band combination with CA in TS 38.101-1 [4] provides the configurations of channel bandwidth, SCS and bandwidth combination set of the bands for each SUL combination. The SUL configuration information is also included in the configuration tables for the allowed SUL configurations supported by the specification.

For the sake of brevity and to reduce the size of SUL band combination with intra-band contiguous CA, intra-band non-contiguous CA and inter-band CA, instead of showing explicitly in the SUL configuration tables, the SCS info for each NR band and SUL band in the configuration is referred to the channel bandwidths for each NR band in clause 5.3.5 of TS 38.101-1 [4]. Examples:

For SUL band combination with intra-band non-contiguous CA, Table 6.8.3-1 illustrates that,

- CA\_n78(2A)-n86A consists of NR band n78 and SUL band n86 whose SCS values are defined in Table 6.8.1-2. For example, for SUL band n86, the supported channel bandwidth in BCS0 is 5MHz, 10MHz, 15MHz and 20MHz where channel bandwidth 5MHz supports SCS with only 15kHz, channel bandwidths 10MHz, 15MHz and 20MHz support all SCS of {15kHz, 30kHz, 60kHz}.

- CA\_n78(2A) with intra-band non-contiguous CA, the configuration is referred to BCS0 defined in clause 5.5A.2 of TS 38.101-1 for intra-band non-contiguous CA configuration table.

- The SUL configuration for SUL\_n78A-n86A can be referred to Table 6.8.3-4.

For SUL band combination with intra-band contiguous CA, Table 6.8.3-2 illustrates that,

- SUL\_n41C-n80A consists of NR band n41 and SUL band n80 whose SCS values are defined in Table 6.8.1-2. For example, for SUL band n80, the supported channel bandwidth in BCS0 is 5MHz, 10MHz, 15MHz, 20MHz, 25MHz, 30MHz and 40MHz where channel bandwidth 5MHz supports SCS with only 15kHz, channel bandwidths 10MHz, 15MHz, 20MHz, 25MHz, 30MHz and 40MHz support all SCS of {15kHz, 30kHz, 60kHz}.

- CA\_n41C with intra-band contiguous CA, the configuration is referred to BCS0 defined in clause 5.5A.1 of TS 38.101-1 for intra-band contiguous CA configuration table.

- The SUL configuration for SUL\_n41A-n80A can be referred to Table 6.8.3-4.

For SUL band combination with inter-band CA, Table 6.8.3-3 illustrates that,

- CA\_n1A\_n78A-n80A consists of NR band n1 and SUL band combination of SUL\_n78A-n80A, whose SCS values are defined in Table 6.8.1-2. For example, for NR band n1, the supported channel bandwidth in BCS0 is 5MHz, 10MHz, 15MHz, 20MHz, 25MHz, 30MHz, 40MHz and 50MHz where channel bandwidth 5MHz supports SCS with only 15kHz, channel bandwidths 10MHz, 15MHz, 20MHz, 25MHz, 30MHz, 40MHz and 50MHz support all SCS of {15kHz, 30kHz, 60kHz}.

- The SUL configuration for SUL\_n78A-n80A can be referred to Table 6.8.3-4.

Table 6.8.3-1: Supported channel bandwidths per SUL band combination with intra-band non-contiguous CA

| SUL band combination with intra-band non-contiguous CA | SUL configuration | NR Band | Channel bandwidth (MHz) (NOTE 1) | Bandwidth combination set |
| --- | --- | --- | --- | --- |
| … | … | … | … | … |
| CA\_n78(2A)-n86A | SUL\_n78A-n86A | n78 | CA\_n78(2A)\_BCS0 | 0 |
|  |  | n86 | 5, 10, 15, 20 |  |
| … | … | … | … | … |
| NOTE 1: The SCS of each channel bandwidth for NR band refers to Table 5.3.5-1. | | | | |

Table 6.8.3-2: Supported channel bandwidths per SUL band combination with intra-band contiguous CA

| SUL band combination with CA | SUL configuration | NR Band | | Channel bandwidth (MHz) (NOTE 1) | | Bandwidth combination set |
| --- | --- | --- | --- | --- | --- | --- |
| … | … | | … | | … | … |
| CA\_n41C-n80A | SUL\_n41A-n80A  CA\_n41C-n80A | | n41 | | CA\_n41C\_BCS1 | 0 |
|  |  | | n80 | | 5, 10, 15, 20, 25, 30, 40 |  |
| … | … | | … | | … | … |
| NOTE 1: The SCS of each channel bandwidth for NR band refers to Table 5.3.5-1. | | | | | | |

Table 6.8.3-3: Supported channel bandwidths per SUL band combination with inter-band CA

| SUL band combination with CA | UL configuration | NR Band | Channel bandwidth (MHz) (NOTE 1) | Bandwidth combination set |
| --- | --- | --- | --- | --- |
| … | … | … | … | … |
| CA\_n1A\_n78A-n80A | SUL\_n78A-n80A | n1 | 5, 10, 15, 20, 25, 30, 40, 50 | 0 |
|  |  | n78 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 |  |
|  |  | n80 | 5, 10, 15, 20, 25, 30, 40 |  |
| … | … | … | … | … |

Table 6.8.3-4: Supported channel bandwidths per SUL band combination

| SUL configuration | NR Band | Channel bandwidth (MHz) (NOTE 1) | Bandwidth combination set |
| --- | --- | --- | --- |
| … | … | … | … |
| SUL\_n41A-n80A | n41 | 10, 15, 20, 40, 50, 60, 80, 90, 100 | 0 |
|  | n80 | 5, 10, 15, 20, 25, 30 |  |
|  | n41 | 10, 15, 20, 30, 40, 50, 60, 80, 90, 100 | 1 |
|  | n80 | 5, 10, 15, 20, 25, 30, 40 |  |
| … | … | … | … |
| SUL\_n78A-n80A | n78 | 10, 15, 20, 40, 50, 60, 80, 90, 100 | 0 |
|  | n80 | 5, 10, 15, 20, 25, 30 |  |
|  | n78 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 | 1 |
|  | n80 | 5, 10, 15, 20, 25, 30, 40 |  |
| … | … | … | … |
| SUL\_n78A-n86A | n78 | 10, 15, 20, 40, 50, 60, 70, 80, 90, 100 | 0 |
|  | n86 | 5, 10, 15, 20 |  |
| … | … | … | … |
| NOTE 1: The SCS of each channel bandwidth for NR band refers to Table 5.3.5-1. | | | |

# 7 Test burden reduction for band combinations

## 7.1 General

One of the objectives in this SI is to investigate the feasibility and optimize the specification structure and reduce the test burden. Currently, the main RF requirements related to specific band combinations include maximum output power (MOP), spurious emission for UE-to-UE coexistence, REFSENS and REFSENS exceptions due to harmonic/harmonic mixing/cross band isolation/IMD interference. Obviously, RF requirements for different features on the same band combination have some similarities and dependency. Especially, the RF implementations are similar and RF architectures can be reused for different features on the same band combination. It’s very meaningful to study the similarity and dependency of RF requirements for different features on the same band combination and find out the feasibility to further optimize the specification structure and reduce the test burden. For example, CA\_nA-nB (NR CA), DC\_nA-nB (NR-DC), DC\_A\_nB (EN-DC), DC\_B\_nA (EN-DC), DC\_nB\_A (NE-DC), DC\_nA\_B (NE-DC) (different features on same band combination) can use same RF implementation.

## 7.2 Similarity and Dependency of Tx RF requirements for different features on the same band combination

### 7.2.1 Maximum output power

As an example, PC3 MOP requirements for all the UL NR CA, UL NR DC, EN-DC and NE-DC band combinations in table 7.2.1-1 based on the TS 38.101-1-h60 and TS 38.101-3-h60. One band combination may be chosen to verify PC3 MOP testing for some band combinations in same row in table 7.2.1-1, as a result of reducing test burden. It’s suggested to randomly choose one band combination that UE support for MOP testing. The proposed test reduction could be considered for an informative annex in the TS since the final decision should be taken by RAN5 based on the industry certification testing needs.

Table 7.2.1-1: Band combination PC3 MOP requirements for the same frequency range with different features

| Uplink NR CA Configuration | Uplink NR DC Configuration | Uplink EN-DC Configuration | Uplink NE-DC Configuration | Class 3 (dBm) | Tolerance (dB) |
| --- | --- | --- | --- | --- | --- |
| CA\_n1A-n3A | DC\_n1A-n3A | DC\_1A\_n3A  DC\_3A\_n1A  DC\_1A\_n80A  DC\_3A\_n84A | DC\_n3A\_1A | 23 | +2/-3 |
| CA\_n1A-n5A |  | DC\_1A\_n5A |  | 23 | +2/-3 |
| CA\_n1A-n7A | DC\_n1A-n7A | DC\_1A\_n7A  DC\_7A\_n1A |  | 23 | +2/-3 |
| CA\_n1A-n8A |  | DC\_1A\_n8A  DC\_8A\_n1A | DC\_n8A\_1A | 23 | +2/-3 |
| CA\_n1A-n18A |  |  |  | 23 | +2/-3 |
| CA\_n1A-n20A |  | DC\_1A\_n20A  DC\_20A\_n1A |  | 23 | +2/-3 |
| CA\_n1A-n28A | DC\_n1A-n28A | DC\_1A\_n28A  DC\_28A\_n1A | DC\_n1A\_28A | 23 | +2/-3 |
|  |  | DC\_1A\_n38A  DC\_38A\_n1A |  | 23 | +2/-3 |
| CA\_n1A-n40A |  | DC\_1A\_n40A  DC\_40A\_n1A |  | 23 | +2/-3 |
| CA\_n1A-n41A | DC\_n1A-n41A | DC\_1A\_n41A  DC\_41A\_n1A |  | 23 | +2/-3 |
|  |  | DC\_1A\_n50A |  | 23 | +2/-3 |
|  |  | DC\_1A\_n51A |  | 23 | +2/-3 |
|  |  | DC\_1A\_n71A |  | 23 | +2/-3 |
| CA\_n1A-n74A |  |  |  | 23 | +2/-3 |
| CA\_n1A-n77A | DC\_n1A-n77A | DC\_1A\_n77A  DC\_1A\_n84A\_ULSUP-TDM\_n77A | DC\_n77A\_1A | 23 | +2/-3 |
| CA\_n1A-n78A | DC\_n1A-n78A | DC\_1A\_n78A  DC\_1A\_n84A\_ULSUP-TDM\_n78A | DC\_n78A\_1A | 23 | +2/-3 |
| CA\_n1A-n79A | DC\_n1A-n79A | DC\_1A\_n79A  DC\_1A\_n84A\_ULSUP-TDM\_n79A |  | 23 | +2/-3 |
| CA\_n2A-n5A | DC\_n2A-n5A | DC\_2A\_n5A  DC\_5A\_n2A |  | 23 | +2/-3 |
| CA\_n2A-n7A |  | DC\_2A\_n7A  DC\_7A\_n2A |  | 23 | +2/-3 |
| CA\_n2A-n12A |  | DC\_2A\_n12A  DC\_12A\_n2A |  | 23 | +2/-3 |
| CA\_n2A-n14A |  | DC\_14A\_n2A |  | 23 | +2/-3 |
|  |  | DC\_2A\_n25A |  | 23 | +2/-3 |
|  |  | DC\_2A\_n28A  DC\_28A\_n2A |  | 23 | +2/-3 |
| CA\_n2A-n30A |  | DC\_2A\_n30A  DC\_30A\_n2A |  | 23 | +2/-3 |
|  |  | DC\_2A\_n38A |  | 23 | +2/-3 |
|  |  | DC\_2A\_n41A |  | 23 | +2/-3 |
|  |  | DC\_2A\_n46A |  | 23 | +2/-3 |
| CA\_n2A-n48A | DC\_n2A-n48A | DC\_2A\_n48A  DC\_48A\_n2A |  | 23 | +2/-3 |
| CA\_n2A-n66A | DC\_n2A-n66A | DC\_2A\_n66A  DC\_66A\_n2A |  | 23 | +2/-3 |
|  |  | DC\_2A\_n71A  DC\_71A\_n2A |  | 23 | +2/-3 |
| CA\_n2A-n77A | DC\_n2A-n77A | DC\_2A\_n77A |  | 23 | +2/-3 |
| CA\_n2A-n78A |  | DC\_2A\_n78A |  | 23 | +2/-3 |
| CA\_n3A-n5A |  | DC\_3A\_n5A |  | 23 | +2/-3 |
| CA\_n3A-n7A |  | DC\_3A\_n7A  DC\_7A\_n3A  DC\_7A\_n80A |  | 23 | +2/-3 |
| CA\_n3A-n8A |  | DC\_3A\_n8A  DC\_8A\_n3A  DC\_8A\_n80A | DC\_n3A\_8A  DC\_n8A\_3A | 23 | +2/-3 |
| CA\_n3A-n18A |  | DC\_18A\_n3A |  | 23 | +2/-3 |
| CA\_n3A-n20A |  | DC\_3A\_n20A  DC\_3A\_n82A  DC\_20A\_n3A  DC\_20A\_n80A |  | 23 | +2/-3 |
| CA\_n3A-n28A | DC\_n3A-n28A | DC\_3A\_n28A  DC\_28A\_n3A | DC\_n28A\_3A | 23 | +2/-3 |
| CA\_n3A-n34A |  |  |  | 23 | +2/-3 |
| CA\_n3-n38A |  | DC\_3A\_n38A  DC\_38A\_n3A |  | 23 | +2/-3 |
| CA\_n3A-n40A |  | DC\_3A\_n40A |  | 23 | +2/-3 |
| CA\_n3A-n41A | DC\_n3A-n41A | DC\_3A\_n41A  DC\_3A\_n80A\_ULSUP-TDM\_n41  DC\_41A\_n3A | DC\_n41A\_3A | 23 | +2/-3 |
|  |  | DC\_3A\_n50A |  | 23 | +2/-3 |
|  |  | DC\_3A\_n51A |  | 23 | +2/-3 |
|  |  | DC\_3A\_n71A |  | 23 | +2/-3 |
| CA\_n3A-n74A |  |  |  | 23 | +2/-3 |
| CA\_n3A-n77A | DC\_n3A-n77A | DC\_3A\_n77A  DC\_3A\_n80A\_ULSUP-TDM\_n77A | DC\_n77A\_3A | 23 | +2/-3 |
| CA\_n3A-n78A | DC\_n3A-n78A | DC\_3A\_n78A  DC\_3A\_n80A\_ULSUP-TDM\_n78A | DC\_n78A\_3A | 23 | +2/-3 |
| CA\_n3A-n79A | DC\_n3A-n79A | DC\_3A\_n79A  DC\_3A\_n80A\_ULSUP-TDM\_n79A |  | 23 | +2/-3 |
|  |  | DC\_4A\_n2A |  | 23 | +2/-3 |
|  |  | DC\_4A\_n5A |  | 23 | +2/-3 |
|  |  | DC\_4A\_n7A |  | 23 | +2/-3 |
|  |  | DC\_4A\_n28A |  | 23 | +2/-3 |
|  |  | DC\_4A\_n38A |  | 23 | +2/-3 |
|  |  | DC\_4A\_n41A |  | 23 | +2/-3 |
|  |  | DC\_4A\_n78A |  | 23 | +2/-3 |
| CA\_n5A-n7A |  | DC\_5A\_n7A  DC\_7A\_n5A |  | 23 | +2/-3 |
| CA\_n5A-n12A |  | DC\_5A\_n12A  DC\_12A\_n5A |  | 23 | +2/-3 |
| CA\_n5A-n14A |  | DC\_14A\_n5A |  | 23 | +2/-3 |
| CA\_n5A-n25A |  |  |  | 23 | +2/-3 |
| CA\_n5A-n30A |  | DC\_5A\_n30A  DC\_30A\_n5A |  | 23 | +2/-3 |
|  |  | DC\_5A\_n38A |  | 23 | +2/-3 |
| CA\_n5A-n40A |  | DC\_5A\_n40A |  | 23 | +2/-3 |
| CA\_n5A-n48A | DC\_n5A-n48A | DC\_5A\_n48A  DC\_48A\_n5A |  | 23 | +2/-3 |
| CA\_n5A-n66A | DC\_n5A-n66A | DC\_5A\_n66A  DC\_66A\_n5A |  | 23 | +2/-3 |
|  |  | DC\_5A\_n71A  DC\_71A\_n5A |  | 23 | +2/-3 |
| CA\_n5A-n77A | DC\_n5A-n77A | DC\_5A\_n77A |  | 23 | +2/-3 |
| CA\_n5A-n78A |  | DC\_5A\_n78A | DC\_n78A\_5A | 23 | +2/-3 |
| CA\_n5A-n79A |  | DC\_5A\_n79A |  | 23 | +2/-3 |
|  |  | DC\_7A\_n8A  DC\_8A\_n7A |  | 23 | +2/-3 |
|  |  | DC\_7A\_n20A  DC\_20A\_n7A |  | 23 | +2/-3 |
| CA\_n7A-n25A |  | DC\_7A\_n25A |  | 23 | +2/-3 |
| CA\_n7A-n28A |  | DC\_7A\_n28A  DC\_28A\_n7A |  | 23 | +2/-3 |
| CA\_n7A-n40A |  | DC\_7A\_n40A |  | 23 | +2/-3 |
| CA\_n7A-n46A | DC\_n7A-n46A |  |  | 23 | +2/-3 |
|  |  | DC\_7A\_n51A |  | 23 | +2/-3 |
| CA\_n7A-n66A |  | DC\_7A\_n66A  DC\_66A\_n7A |  | 23 | +2/-3 |
|  |  | DC\_7A\_n71A |  | 23 | +2/-3 |
| CA\_n7A-n77A |  | DC\_7A\_n77A |  | 23 | +2/-3 |
| CA\_n7A-n78A | DC\_n7A-n78A | DC\_7A\_n78A | DC\_n78A\_7A | 23 | +2/-3 |
|  |  | DC\_7A\_n79A |  | 23 | +2/-3 |
|  |  | DC\_8A\_n2A |  | 23 | +2/-3 |
|  |  | DC\_8A\_n20A  DC\_20A\_n8A |  | 23 | +2/-3 |
|  |  | DC\_8A\_n28A  DC\_28A\_n8A | DC\_n28A\_8A |  |  |
| CA\_n8A-n34A |  | DC\_8A\_n34A |  | 23 | +2/-3 |
| CA\_n8A-n39A |  | DC\_8A\_n39A |  | 23 | +2/-3 |
| CA\_n8A-n40A |  | DC\_8A\_n40A |  | 23 | +2/-3 |
| CA\_n8A-n41A |  | DC\_8A\_n41A  DC\_8A\_n81A\_ULSUP-TDM\_n41 | DC\_n41A\_8A | 23 | +2/-3 |
| CA\_n8A-n77A |  | DC\_8A\_n77A | DC\_n77A\_8A | 23 | +2/-3 |
| CA\_n8A-n78A |  | DC\_8A\_n78A  DC\_8A\_n81A\_ULSUP-TDM\_n78A | DC\_n78A\_8A | 23 | +2/-3 |
| CA\_n8A-n79A |  | DC\_8A\_n79A  DC\_8A\_n81A\_ULSUP-TDM\_n79A |  | 23 | +2/-3 |
|  |  | DC\_11A\_n1A |  | 23 | +2/-3 |
|  |  | DC\_11A\_n3A |  | 23 | +2/-3 |
|  |  | DC\_11A\_n28A |  | 23 | +2/-3 |
|  |  | DC\_11A\_n41A |  | 23 | +2/-3 |
|  |  | DC\_11A\_n77A |  | 23 | +2/-3 |
|  |  | DC\_11A\_n78A |  | 23 | +2/-3 |
|  |  | DC\_11A\_n79A |  | 23 | +2/-3 |
|  |  | DC\_12A\_n7A |  | 23 | +2/-3 |
|  |  | DC\_12A\_n25A |  | 23 | +2/-3 |
| CA\_n12A-n30A |  | DC\_12A\_n30A |  | 23 | +2/-3 |
|  |  | DC\_12A\_n38A |  | 23 | +2/-3 |
|  |  | DC\_12A\_n41A |  | 23 | +2/-3 |
| CA\_n12A-n66A |  | DC\_12A\_n66A  DC\_66A\_n12A |  | 23 | +2/-3 |
|  |  | DC\_12A\_n71A |  | 23 | +2/-3 |
| CA\_n12A-n77A |  | DC\_12A\_n77A |  | 23 | +2/-3 |
|  |  | DC\_12A\_n78A |  | 23 | +2/-3 |
|  |  | DC\_13A\_n2A |  | 23 | +2/-3 |
|  |  | DC\_13A\_n5A |  | 23 | +2/-3 |
|  |  | DC\_13A\_n7A |  | 23 | +2/-3 |
| CA\_n13A-n25A |  | DC\_13A\_n25A |  | 23 | +2/-3 |
|  |  | DC\_13A\_n48A |  | 23 | +2/-3 |
| CA\_n13A-n66A |  | DC\_13A\_n66A |  | 23 | +2/-3 |
|  |  | DC\_13A\_n71A |  | 23 | +2/-3 |
| CA\_n13A-n77A |  | DC\_13A\_n77A |  | 23 | +2/-3 |
|  |  | DC\_13A\_n78A |  | 23 | +2/-3 |
| CA\_n14A-n30A |  | DC\_14A\_n30A |  | 23 | +2/-3 |
| CA\_n14A-n66A |  | DC\_14A\_n66A |  | 23 | +2/-3 |
| CA\_n14A-n77A |  | DC\_14A\_n77A |  | 23 | +2/-3 |
| CA\_n18A-n28A |  | DC\_18A\_n28A |  | 23 | +2/-3 |
| CA\_n18A-n41A |  | DC\_18A\_n41A |  | 23 | +2/-3 |
| CA\_n18A-n74A |  |  |  | 23 | +2/-3 |
| CA\_n18A-n77A |  | DC\_18A\_n77A |  | 23 | +2/-3 |
| CA\_n18A-n78A |  | DC\_18A\_n78A |  | 23 | +2/-3 |
|  |  | DC\_18A\_n79A |  | 23 | +2/-3 |
|  |  | DC\_19A\_n1A |  | 23 | +2/-3 |
|  |  | DC\_19A\_n77A |  | 23 | +2/-3 |
|  |  | DC\_19A\_n78A |  | 23 | +2/-3 |
|  |  | DC\_19A\_n79A |  | 23 | +2/-3 |
| CA\_n20A-n28A |  | DC\_20A\_n28A  DC\_20A\_n83A | DC\_n28A\_20A | 23 | +2/-3 |
|  |  | DC\_20A\_n38A |  | 23 | +2/-3 |
|  |  | DC\_20A\_n41A |  | 23 | +2/-3 |
|  |  | DC\_20A\_n50A |  | 23 | +2/-3 |
|  |  | DC\_20A\_n51A |  | 23 | +2/-3 |
|  |  | DC\_20A\_n77A |  | 23 | +2/-3 |
| CA\_n20A-n78A |  | DC\_20A\_n78A  DC\_20A\_n82A\_ULSUP-TDM\_n78A |  | 23 | +2/-3 |
|  |  | DC\_21A\_n1A |  | 23 | +2/-3 |
|  |  | DC\_21A\_n28A |  | 23 | +2/-3 |
|  |  | DC\_21A\_n77A |  | 23 | +2/-3 |
|  |  | DC\_21A\_n78A |  | 23 | +2/-3 |
|  |  | DC\_21A\_n79A |  | 23 | +2/-3 |
| CA\_n24A-n41A |  |  |  | 23 | +2/-3 |
| CA\_n24A-n48A |  |  |  | 23 | +2/-3 |
| CA\_n24A-n77A |  |  |  | 23 | +2/-3 |
| CA\_n25A-n38A |  | DC\_25A\_n41A |  | 23 | +2/-3 |
| CA\_n25A-n41A |  |  |  | 23 | +2/-3 |
| CA\_25A-n48A |  | DC\_48A\_n25A |  | 23 | +2/-3 |
| CA\_n25A-n66A |  | DC\_66A\_n25A |  | 23 | +2/-3 |
| CA\_n25A-n77A |  | DC\_25A\_n77A |  | 23 | +2/-3 |
| CA\_n25A-n78A |  | DC\_25A\_n78A |  | 23 | +2/-3 |
|  |  | DC\_26A\_n25A |  | 23 | +2/-3 |
|  |  | DC\_26A\_n41A |  | 23 | +2/-3 |
| CA\_n26A-n66A |  |  |  | 23 | +2/-3 |
| CA\_n26A-n70A |  |  |  | 23 | +2/-3 |
|  |  | DC\_26A\_n77A |  | 23 | +2/-3 |
|  |  | DC\_26A\_n78A | DC\_n78A\_26A | 23 | +2/-3 |
|  |  | DC\_26A\_n79A |  | 23 | +2/-3 |
|  |  | DC\_28A\_n5A |  | 23 | +2/-3 |
| CA\_n28A-n34A |  |  | DC\_n28A\_34A | 23 | +2/-3 |
| CA\_n28A-n39A |  |  | DC\_n28A\_39A | 23 | +2/-3 |
| CA\_n28A-n40A |  | DC\_28A\_n40A | DC\_n28A\_40A | 23 | +2/-3 |
| CA\_n28A-n41A | DC\_n28A-n41A | DC\_28A\_n41A  DC\_28A\_n83A\_ULSUP-TDM\_n41A  DC\_41A\_n28A |  | 23 | +2/-3 |
| CA\_n28A-n46A | DC\_n28A-n46A |  |  | 23 | +2/-3 |
| CA\_n28A-n50A |  | DC\_28A\_n50A |  | 23 | +2/-3 |
|  |  | DC\_28A\_n51A |  | 23 | +2/-3 |
|  |  | DC\_28A\_n66A  DC\_66A\_n28A |  | 23 | +2/-3 |
| CA\_n28A-n74A |  |  |  | 23 | +2/-3 |
| CA\_n28A-n77A | DC\_n28A-n77A | DC\_28A\_n77A |  | 23 | +2/-3 |
| CA\_n28A-n78A | DC\_n28A-n78A | DC\_28A\_n78A  DC\_28A\_n83A\_ULSUP-TDM\_n78A |  | 23 | +2/-3 |
| CA\_n28A-n79A | DC\_n28A-n79A | DC\_28A\_n79A |  | 23 | +2/-3 |
| CA\_n34A-n79A |  |  |  | 23 | +2/-3 |
| CA\_n30A-n66A |  | DC\_30A\_n66A  DC\_66A\_n30A |  | 23 | +2/-3 |
| CA\_n30A-n77A |  | DC\_30A\_n77A |  | 23 | +2/-3 |
| CA\_n34A-n40A |  |  |  | 23 | +2/-3 |
| CA\_n34A-n41A |  |  | DC\_n41A\_34A | 23 | +2/-3 |
|  |  | DC\_38A\_n8A |  | 23 | +2/-3 |
|  |  | DC\_38A\_n28A |  | 23 | +2/-3 |
| CA\_n38A-n66A |  | DC\_66A\_n38A |  | 23 | +2/-3 |
| CA\_n38A-n78A |  | DC\_38A\_n78A |  | 23 | +2/-3 |
|  |  | DC\_38A\_n79A |  | 23 | +2/-3 |
| CA\_n39A-n40A |  | DC\_39A\_n40A |  | 23 | +2/-3 |
| CA\_n39A-n41A |  | DC\_39A\_n41A | DC\_n41A\_39A | 23 | +2/-3 |
|  |  | DC\_39A\_n78A |  | 23 | +2/-3 |
| CA\_n39A-n79A |  | DC\_39A\_n79A |  | 23 | +2/-3 |
| CA\_n40A-n41A |  | DC\_40A\_n41A | DC\_n41A\_40A | 23 | +2/-3 |
| CA\_n40A-n77A |  | DC\_40A\_n77A |  | 23 | +2/-3 |
| CA\_n40A-n78A |  | DC\_40A\_n78A |  | 23 | +2/-3 |
| CA\_n40A-n79A |  | DC\_40A\_n79A |  | 23 | +2/-3 |
| CA\_n41A-n48A |  |  |  | 23 | +2/-3 |
| CA\_n41A-n50A |  |  |  | 23 | +2/-3 |
| CA\_n41A-n66A |  | DC\_66A\_n41A |  | 23 | +2/-3 |
| CA\_n41A-n70A |  |  |  | 23 | +2/-3 |
| CA\_n41A-n71A |  | DC\_71A\_n41A |  | 23 | +2/-3 |
| CA\_n41A-n74A |  |  |  | 23 | +2/-3 |
| CA\_n41A-n77A | DC\_n41A-n77A | DC\_41A\_n77A |  | 23 | +2/-3 |
| CA\_n41A-n78A | DC\_n41A-n78A | DC\_41A\_n78A |  | 23 | +2/-3 |
| CA\_n41A-n79A |  | DC\_41A\_n79A |  | 23 | +2/-3 |
|  |  | DC\_42A\_n1A |  | 23 | +2/-3 |
|  |  | DC\_42A\_n3A |  | 23 | +2/-3 |
|  |  | DC\_42A\_n28A |  | 23 | +2/-3 |
|  |  | DC\_42A\_n51A |  | 23 | +2/-3 |
|  |  | DC\_42A\_n77A |  | 23 | +2/-3 |
|  |  | DC\_42A\_n78A |  | 23 | +2/-3 |
|  |  | DC\_42A\_n79A |  | 23 | +2/-3 |
| CA\_n46A-n48A | DC\_n46A-n48A |  |  | 23 | +2/-3 |
| CA\_n46A-n48B | DC\_n46A-n48B |  |  | 23 | +2/-3 |
| CA\_n46A-n78A | DC\_n46A-n78A |  |  | 23 | +2/-3 |
|  |  | DC\_48A\_n12A |  | 23 | +2/-3 |
| CA\_n48A-n66A | DC\_n48A-n66A | DC\_48A\_n66A  DC\_66A\_n48A |  | 23 | +2/-3 |
| CA\_n48A-n70A | DC\_n48A-n70A |  |  | 23 | +2/-3 |
| CA\_n48A-n71A | DC\_n48A-n71A | DC\_48A\_n71A  DC\_71A\_n48A |  | 23 | +2/-3 |
| CA\_n48A-n96A | DC\_n48A-n96A |  |  | 23 | +2/-3 |
| CA\_n48B-n96A | DC\_n48B-n96A |  |  | 23 | +2/-3 |
| CA\_n48A-n96B |  |  |  | 23 | +2/-3 |
| CA\_n50A-n78A |  |  |  | 23 | +2/-3 |
|  |  | DC\_66A\_n46A |  | 23 | +2/-3 |
| CA\_n66A-n71A |  | DC\_66A\_n71A  DC\_71A\_n66A |  | 23 | +2/-3 |
| CA\_n66A-n77A | DC\_n66A-n77A | DC\_66A\_n77A |  | 23 | +2/-3 |
| CA\_n66A-n78A |  | DC\_66A\_n78A  DC\_66A\_n86A\_ULSUP-TDM\_n78A |  | 23 | +2/-3 |
| CA\_n70A-n71A |  |  |  | 23 | +2/-3 |
| CA\_n70A-n78A |  |  |  | 23 | +2/-3 |
|  |  | DC\_71A\_n38A |  | 23 | +2/-3 |
| CA\_n71A-n77A |  |  |  | 23 | +2/-3 |
| CA\_n71A-n78A |  | DC\_71A\_n78A |  | 23 | +2/-3 |
| CA\_n74A-n77A |  |  |  | 23 | +2/-3 |
| CA\_n74A-n78A |  |  |  | 23 | +2/-3 |
| CA\_n77A-n79A | DC\_n77A-n79A |  |  | 23 | +2/-3 |
| CA\_n78A-n79A |  |  |  | 23 | +2/-3 |
| CA\_n78A-n92A |  |  |  | 23 | +2/-3 |

### 7.2.2 Spurious emission for UE-to-UE coexistence

Generally, if CA\_nA-nB, DC\_A\_nB (DC\_A\_nD), DC\_B\_nA (DC\_B\_nC), DC\_nB\_A, DC\_nA\_B have same spurious emission requirements for UE to UE coexistence, it may not be needed to test the spurious emission requirements for UE to UE coexistence for each UL configuration again and again. Once one of these UL configurations is verified, the other UL configurations for different feature in same band combination can be considered as being capable of meeting these requirements.

NOTE: Band nC and nD are the corresponding SUL bands with same UL frequency range of band nA and nB, e.g. SUL band n80 has same UL frequency range of band n3.

## 7.3 Similarity and Dependency of Rx RF requirements for different features on the same band combination

### 7.3.1 REFSENS exception due to harmonic/harmonic mixing interference for inter-band combinations (two bands)

For reference sensitivity exception due to harmonic/harmonic mixing specified for ENDC/NEDC band combinations, it’s suggested to follow the same principles as for NR CA BCS4 WI in WF R4-2210565 as a starting point.

### 7.3.2 REFSENS exception due to cross band isolation interference for inter-band combinations (two bands)

For reference sensitivity exception due to cross band isolation specified for ENDC band combinations, it’s suggested to follow the same principles as for NR CA BCS4 WI in WF R4-2210565 as a starting point.

The following guidelines clarify WF R4-2210565 with regards to specifying MSD test points due to cross-band isolation when the UL band is an FDD band configured for intra-band uplink CA operation.

Guidelines for cross-band isolation MSD due to FDD band dual uplink intra-band contiguous CA interference:

1 FDD band intra-band contiguous uplink CA configuration:

a) PCC/SCC: the UL CBW, SCS, and UL RB allocation "Lcrb" should be configured to the specified PCC/SCC CBW/SCS/Lcrb of the band's MSD test point.

For example, for uplink CA\_n5B, the PCC/SCC CBW, SCS and Lcrb should be configured according to the TS38.101-1 Table 7.3A.2.1-1, i.e. CBW: 10MHz+10MHz, SCS:15/15 (kHz), Lcrb:10RB/10RB.

In case the FDD band UL-CA MSD test point is not specified:

i) The PCC/SCC UL CBW shall be set equal.

If configuring equal CBW is not possible, then set the PCC CBW 5MHz smaller [R4-2320995].

ii) The aggregated UL RB allocation (aka "RBtot") is set equal to the Lcrb specified for the single carrier REFSENS test point that corresponds to the UL-CA aggregated BW.

Example, for UL-CA 10MHz+10MHz, adopt the Lcrb specified for 20MHz CBW REFSENS [R4-2320995].

iii) The PCC/SCC UL RB allocation "Lcrb" should be configured to ensure equal PSD between across the PCC and the SCC.

b) The PCC/SCC UL RBstart shall be configured to create a direct hit collision of the affected DL SCC with the lowest 2UL IMD product. If conditions to create a direct hit collision cannot be met, then configure the PCC/SCC RBstart that results in a partial collision of the lowest 2UL IMD product.

c) The highest IMD order to be considered is [13].

d) Configure the UL carrier frequency closest to the affected DL SCC carrier frequency.

e) Whenever possible, the UL band configuration should be configured to avoid self-desense.

In case self-desense cannot be avoided:

i) The MSD test point shall not lead to a higher desense than the band's MSD test point (when specified),

ii) To prevent radio link failure during conformance test, RAN5 should be informed that self-desense may occur on the UL FDD band.

2) Affected DL band SCC configuration:

a) DL SCC carrier frequency: configured closest to the FDD UL-CA carrier.

b) DL SCC CBW: configured to its smallest supported CBW.

The following guidelines clarify WF R4-2210565 with regards to specifying MSD test points due to cross-band isolation for SUL and their NR-CA counterparts.

Guidelines for MSD test points due to cross-band isolation for SUL:

- For SUL band combinations, and for the first test point which evaluates the MSD for the lowest DL CBW, the SUL band should be configured with the highest supported CBW, as specified in Table 5.5C-1. This ensures that the SUL band lowest IMD order has a maximum reach towards the DL affected band.

- For the second test point, the choice of the SUL CBW remains open to account for exceptions or regional concerns, or to address a proponent’s request.

- The SUL SCS should be the lowest SCS that can be supported for the selected SUL CBW. For example, if the SUL CBW is 50 MHz, then SCS15 kHz should be specified.

- For the UL configuration "Lcrb" for the SUL band: The UL Lcrb of the NR band counterpart as defined in Table 7.3.2-3 (UL configuration for UL Band REFSENS) for the corresponding SUL band CBW is specified. A SUL-NR counterpart look-up is provided in Table 7.3.2-1.

Table 7.3.2-1: 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 |

- The SUL RBstart should ensure that the UL RBs are positioned closest to the DL affected band.

- The SUL carrier center frequency should be configured closest to the affected DL band.

### 7.3.3 REFSENS exception due to inter-modulation distortion for inter-band combinations (two bands)

MSD due to IMD for NR CA, NR DC, EN-DC and NE-DC band combinations with two bands are shown in table 7.3.3-1 based on the TS 38.101-1 v18.0.0 and TS 38.101-3 v18.0.0. One band combination can be chosen to verify the requirements for some band combinations in same row in table 7.3.3-1, as a result of reducing test burden. It’s suggested to randomly choose one band combination that UE support for MSD testing. The final decision should be taken by RAN5 based on the industry certification testing needs.

Table 7.3.3-1 Band combination with different features in the same frequency range for PC3 MSD due to IMD interference

| NR or E-UTRA Band / Channel bandwidth / NRB / MSD | | | | | | | | Band / Channel bandwidth / NRB / Duplex mode | | | | | | | | Source of IMD |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| EN-DC  Configuration | EUTRA or NR band | UL Fc  (MHz) | UL/DL BW  (MHz) | UL  LCRB | DL Fc (MHz) | MSD  (dB) | IMD order | NR CA band combination | NR band | UL Fc  (MHz) | UL/DL BW  (MHz) | UL  CLRB | DL Fc (MHz) | MSD  (dB) | Duplex mode |
| DC\_1\_n3 | 1 | 1950 | 5 | 25 | 2140 | 23 | IMD3 | CA\_n1-n3 | n1 | 1950 | 5 | 25 | 2140 | 23 | FDD | IMD3 |
|  | n3 | 1760 | 5 | 25 | 1855 | N/A | N/A |  | n3 | 1760 | 5 | 25 | 1855 | N/A | TDD | N/A |
| DC\_1A\_n8A | 1 | 1965 | 5 | 25 | 2155 | 6.0 | IMD4 | CA\_n1-n8 | n1 | 1965 | 5 | 25 | 2155 | 6.0 | FDD | IMD4 |
|  | n8 | 887.5 | 5 | 25 | 932.5 | N/A | N/A |  | n8 | 887.5 | 5 | 25 | 932.5 | N/A | FDD | N/A |
| DC\_1A\_n77A,  DC\_1A\_SUL\_n77A-n84A,  DC\_1A\_n77(2A), | 1 | 1950 | 5 | 25 | 2140 | 29.8 | IMD23 | CA\_n1-n77 | 1 | 1950 | 5 | 25 | 2140 | 29.8 | FDD | IMD24 |
|  | n77 | 4090 | 10 | 50 | 4090 | N/A | N/A |  | n77 | 4090 | 10 | 50 | 4090 | N/A | TDD | N/A |
| DC\_1A\_n77A,  DC\_1A\_SUL\_n77A-n84A,  DC\_1A\_n77(2A),  DC\_1A\_n77(3A),  DC\_1A\_n78A,  DC\_1A\_SUL\_n78A-n84A,  DC\_1A\_n78(2A)  DC\_1A\_n78(A-C) | 1 | 1950 | 5 | 25 | 2140 | 8.0 | IMD43 | CA\_n1-n77 | 1 | 1950 | 5 | 25 | 2140 | 8.0 | FDD | IMD44 |
|  | n77, n78 | 3710 | 10 | 50 | 3710 | N/A | N/A |  | n77 | 3710 | 10 | 50 | 3710 | N/A | TDD | N/A |
| DC\_2A\_n48A | 2 | 1852.5 | 5 | 25 | 1932.5 | 12 | IMD4 | CA\_n2-n48 | n2 | 1852.5 | 5 | 25 | 1932.5 | 12 | FDD | IMD4 |
|  | n48 | 3625 | 20 | 100 | 3625 | N/A | N/A |  | n48 | 3625 | 20 | 100 | 3625 | N/A | TDD | N/A |
| DC\_2A\_n66A, DC\_2A-2A\_n66A  DC\_2A\_n66(2A) | 2 | 1855 | 5 | 25 | 1935 | 20 | IMD3 | CA\_n2-n66 | n2 | 1855 | 5 | 25 | 1935 | 20 | FDD | IMD3 |
|  | n66 | 1775 | 5 | 25 | 2175 | N/A | N/A |  | n66 | 1775 | 5 | 25 | 2175 | N/A | FDD | N/A |
| DC\_2A\_n66A, DC\_2A-2A\_n66A  DC\_2A\_n66(2A) | 2 | 1883.3 | 5 | 25 | 1963.3 | N/A | N/A | CA\_n2-n66 | n2 | 1883.3 | 5 | 25 | 1963.3 | N/A | FDD | N/A |
|  | n66 | 1750 | 5 | 25 | 2150 | 4 | IMD5 |  | n66 | 1750 | 5 | 25 | 2150 | 4 | FDD | IMD5 |
| DC\_2A\_n77A  DC\_2A\_n77(2A)  DC\_2A-2A\_n77A  DC\_2A\_n77(2A)  DC\_2A-2A\_n77(2A) | 2 | 1855 | 5 | 25 | 1935 | 26 | IMD2 | CA\_n2-n77 | n2 | 1855 | 5 | 25 | 1935 | 26 | FDD | IMD2 |
|  | n77 | 3790 | 10 | 50 | 3790 | N/A | N/A |  | n77 | 3790 | 10 | 50 | 3790 | N/A | TDD | N/A |
|  | 2 | 1900 | 5 | 25 | 1980 | 8.0 | IMD4 | CA\_n2-n77 | n2 | 1900 | 5 | 25 | 1980 | 8.0 | FDD | IMD4 |
|  | n77 | 3720 | 10 | 50 | 3720 | N/A | N/A |  | n77 | 3720 | 10 | 50 | 3720 | N/A | TDD | N/A |
|  | 2 | 1885 | 5 | 25 | 1965 | 5 | IMD5 | CA\_n2-n77 | n2 | 1885 | 5 | 25 | 1965 | 5 | FDD | IMD5 |
|  | n77 | 3810 | 10 | 50 | 3810 | N/A | N/A |  | n77 | 3810 | 10 | 50 | 3810 | N/A | TDD | N/A |
| DC\_2A\_n78A  DC\_2A\_n78(2A)  DC\_2A-2A\_n78(2A) | 2 | 1855 | 5 | 25 | 1935 | 26 | IMD23 | CA\_n2-n78 | n2 | 1855 | 5 | 25 | 1935 | 26 | FDD | IMD24 |
|  | n78 | 3790 | 10 | 50 | 3790 | N/A | N/A |  | n78 | 3790 | 10 | 50 | 3790 | N/A | TDD | N/A |
| DC\_3\_n1 | 3 | 1760 | 5 | 25 | 1855 | N/A | N/A | CA\_n1-n3 | n1 | 1950 | 5 | 25 | 2140 | 23 | FDD | IMD3 |
|  | n1 | 1950 | 5 | 25 | 2140 | 23 | IMD3 |  | n3 | 1760 | 5 | 25 | 1855 | N/A | TDD | N/A |
| DC\_3\_n5 | 3 | 1771 | 10 | 50 | 1866 | 4 | IMD4 | CA\_n3-n5 | n3 | 1771 | 10 | 50 | 1866 | 4 | FDD | IMD4 |
|  | n5 | 838 | 5 | 25 | 883 | N/A | N/A |  | n5 | 838 | 5 | 25 | 883 | N/A | FDD | N/A |
|  | 3 | 1721 | 10 | 50 | 1816 | N/A | N/A | CA\_n3-n5 | n3 | 1721 | 10 | 50 | 1816 | N/A | FDD | N/A |
|  | n5 | 838 | 5 | 25 | 883 | 24 | IMD23 |  | n5 | 838 | 5 | 25 | 883 | 24 | FDD | IMD23 |
| DC\_3A\_n7A  DC\_3C\_n7A | 3 | 1730 | 5 | 25 | 1825 | N/A | N/A | CA\_n3-n7 | n3 | 1730 | 5 | 25 | 1825 | N/A | FDD | N/A |
|  | n7 | 2535 | 10 | 50 | 2655 | 10.2 | IMD4 |  | n7 | 2535 | 10 | 50 | 2655 | 10.2 | FDD | IMD4 |
| DC\_3\_n8 | n8 | 900 | 5 | 25 | 945 | 8 | IMD43 | CA\_n3-n8 | n3 | 1755 | 10 | 50 | 1850 | N/A | FDD | N/A |
|  | 3 | 1755 | 10 | 50 | 1850 | N/A | N/A |  | n8 | 900 | 5 | 25 | 945 | 8 | FDD | IMD44 |
|  | n8 | 897.5 | 5 | 25 | 942.5 | N/A | N/A | CA\_n3-n8 | n3 | 1747.5 | 10 | 50 | 1842.5 | 6.4 | FDD | IMD5 |
|  | 3 | 1747.5 | 10 | 50 | 1842.5 | 6.4 | IMD5 |  | n8 | 897.5 | 5 | 25 | 942.5 | N/A | FDD | N/A |
| DC\_3A\_n26A | 3 | 1771 | 10 | 50 | 1866 | 4 | IMD4 | CA\_n3-n26 | n3 | 1771 | 5 | 25 | 1866 | 4 | FDD | IMD4 |
|  | n26 | 838 | 5 | 25 | 883 | N/A | N/A |  | n26 | 838 | 5 | 25 | 883 | N/A | FDD | N/A |
|  | 3 | 1721 | 10 | 50 | 1816 | N/A | N/A | CA\_n3-n26 | n3 | 1721 | 5 | 25 | 1816 | N/A | FDD | N/A |
|  | n26 | 838 | 5 | 25 | 883 | 24 | IMD23 |  | n26 | 838 | 5 | 25 | 883 | 26 | FDD | IMD211 |
| DC\_3A\_n38A | 3 | 1712.8 | 5 | 25 | 1807.8 | 8.2 | IMD4 | CA\_n3-n38 | n3 | 1713 | 5 | 25 | 1808 | 8.2 | FDD | IMD4 |
|  | n38 | 2616.7 | 10 | 50 | 2616.7 | N/A | N/A |  | n38 | 2617 | 5 | 25 | 2617 | N/A | TDD | N/A |
| DC\_3A\_n41A  DC\_3C\_n41A  DC\_3A\_SUL\_n41A-n80A, DC\_3C\_SUL\_n41A-n80A | 3 | 1740 | 5 | 25 | 1835 | 8.2 | IMD4 | CA\_n3-n41 | n3 | 1740 | 5 | 25 | 1835 | 8.2 | FDD | IMD4 |
|  | n41 | 2657.5 | 10 | 50 | 2657.5 | N/A | N/A |  | n41 | 2657.5 | 10 | 50 | 2657.5 | N/A | TDD | N/A |
| DC\_3A\_n77A,  DC\_3A\_n77(2A),  DC\_3A\_n77(3A),  DC\_3A\_SUL\_n77A-n80A,  DC\_3A\_n78A,  DC\_3A\_SUL\_n78A-n80A,  DC\_3A\_n78(2A),  DC\_3A\_n78(A-C)  DC\_3C\_n78A  DC\_3C\_n78(2A) | 3 | 1740 | 5 | 25 | 1835 | 26 | IMD23 | CA\_n3-n77  CA\_n3-n78 | n3 | 1740 | 5 | 25 | 1835 | 26 | FDD | IMD24 |
|  | n77, n78 | 3575 | 10 | 50 | 3575 | N/A | N/A |  | n77, n78 | 3575 | 10 | 50 | 3575 | N/A | TDD | N/A |
| DC\_3A\_n77A,  DC\_3A\_n77(2A),  DC\_3C\_n77A,  DC\_3C\_n77(2A),  DC\_3A\_SUL\_n77A-n80A,  DC\_3A\_n78A, DC\_3A\_SUL\_n78A-n80A,  DC\_3A\_n78(2A),  DC\_3C\_n78A  DC\_3C\_n78(2A) | 3 | 1765 | 5 | 25 | 1860 | 8.0 | IMD43 | CA\_n3-n77  CA\_n3-n78 | n3 | 1740 | 5 | 25 | 1835 | 26 | FDD | IMD24 |
|  | n77, n78 | 3435 | 10 | 50 | 3435 | N/A | N/A |  | n77, n78 | 3575 | 10 | 50 | 3575 | N/A | TDD | N/A |
| DC\_5A\_n3A | 5 | 838 | 5 | 25 | 883 | N/A | N/A | CA\_n3-n5 | n3 | 1771 | 10 | 50 | 1866 | 4 | FDD | IMD4 |
|  | n3 | 1771 | 10 | 50 | 1866 | 4 | IMD4 |  | n5 | 838 | 5 | 25 | 883 | N/A | FDD | N/A |
|  | 5 | 838 | 5 | 25 | 883 | 24 | IMD23 | CA\_n3-n5 | n3 | 1721 | 10 | 50 | 1816 | N/A | FDD | N/A |
|  | n3 | 1721 | 10 | 50 | 1816 | N/A | N/A |  | n5 | 838 | 5 | 25 | 883 | 24 | FDD | IMD23 |
| DC\_5\_n7 | n7 | 2547 | 10 | 50 | 2667 | N/A | N/A | CA\_n5-n7 | n5 | 834 | 5 | 25 | 879 | 12 | FDD | IMD34 |
|  | 5 | 834 | 5 | 25 | 879 | 12 | IMD33 |  | n7 | 2547 | 10 | 50 | 2667 | N/A | FDD | N/A |
| DC\_5A\_n66A | 5 | 838 | 5 | 25 | 883 | 30 | IMD23 | CA\_n5-n66 | n5 | 838 | 5 | 25 | 883 | 30 | FDD | IMD24 |
|  | n66 | 1721 | 5 | 25 | 2121 | N/A | N/A |  | n66 | 1721 | 5 | 25 | 2121 | N/A | FDD | N/A |
| DC\_5A\_n77A8  DC\_5A\_n77(2A)8  DC\_5A\_n77(3A)8 | 5 | 844 | 5 | 25 | 889 | 8.3 | IMD4 | CA\_n5-n7713 | n5 | 844 | 5 | 25 | 889 | 8.3 | FDD | IMD4 |
|  | n77 | 3421 | 10 | 50 | 3421 | N/A | N/A |  | n77 | 3421 | 10 | 50 | 3421 | N/A | TDD | N/A |
|  | 5 | 826.5 | 5 | 25 | 871.5 | 5.5 | IMD5 | CA\_n5-n7713 | n5 | 829 | 5 | 25 | 874 | 5.5 | FDD | IMD5 |
|  | n77 | 4177.5 | 10 | 50 | 4177.5 | N/A | N/A |  | n77 | 4190 | 10 | 50 | 4190 | N/A | TDD | N/A |
| DC\_5A\_n78A  DC\_5A\_n78(2A)  DC\_5A\_n78(A-C)  DC\_5A\_n78C | 5 | 844 | 5 | 25 | 889 | 8.3 | IMD4 | CA\_n5-n78 | n5 | 844 | 5 | 25 | 889 | 8.3 | FDD | IMD4 |
|  | n78 | 3421 | 10 | 50 | 3421 | N/A | N/A |  | n78 | 3421 | 10 | 50 | 3421 | N/A | TDD | N/A |
| DC\_7\_n3 | 7 | 2535 | 10 | 50 | 2655 | 13 | IMD4 | CA\_n3-n7 | n3 | 1730 | 5 | 25 | 1825 | N/A | FDD | N/A |
|  | n3 | 1730 | 5 | 25 | 1825 | N/A | N/A |  | n7 | 2535 | 10 | 50 | 2655 | 10.2 | FDD | IMD4 |
| DC\_7\_n5 | 7 | 2547 | 10 | 50 | 2667 | N/A | N/A | CA\_n5-n7 | n5 | 834 | 5 | 25 | 879 | 12 | FDD | IMD34 |
|  | n5 | 834 | 5 | 25 | 879 | 12 | IMD33 |  | n7 | 2547 | 10 | 50 | 2667 | N/A | FDD | N/A |
| DC\_7A\_n26A  DC\_7C\_n26A | 7 | 2547 | 10 | 50 | 2667 | N/A | N/A | CA\_n7-n26 | n7 | 2556 | 5 | 25 | 2676 | N/A | FDD | N/A |
|  | n26 | 834 | 5 | 25 | 879 | 12 | IMD33 |  | n26 | 837 | 5 | 25 | 882 | 16.0 | FDD | IMD311 |
|  | 7 | 2567.5 | 5 | 25 | 2687.5 | 2.5 | IMD5 | CA\_n7-n26 | n7 | 2567.5 | 5 | 25 | 2687.5 | 2.5 | FDD | IMD5 |
|  | n26 | 816.5 | 5 | 25 | 861.5 | N/A | N/A |  | n26 | 816.5 | 5 | 25 | 861.5 | N/A | FDD | N/A |
| DC\_7\_n40 | 7 | 2510 | 5 | 25 | 2630 | 23 | IMD3 | CA\_n7-n40 | n7 | 2510 | 5 | 25 | 2630 | 23 | FDD | IMD3 |
|  | n40 | 2390 | 5 | 25 | 2390 | N/A | N/A |  | n40 | 2390 | 5 | 25 | 2390 | N/A | TDD | N/A |
| DC\_7A\_n66A  DC\_7A-7A\_n66A  DC\_7C\_n66A | 7 | 2535 | 10 | 50 | 2655 | 15 | IMD4 | CA\_n7-n66 | n7 | 2535 | 10 | 50 | 2655 | 15 | FDD | IMD4 |
|  | n66 | 1730 | 5 | 25 | 2130 | N/A | N/A |  | n66 | 1730 | 5 | 25 | 2130 | N/A | FDD | N/A |
| DC\_7A\_n77A  DC\_7A-7A\_n77(2A)  DC\_7A-7A\_n77(3A)  DC\_7A\_n77(2A)  DC\_7A\_n77(3A)  DC\_7C\_n77A  DC\_7C\_n77(2A) | 7 | 2540 | 5 | 25 | 2660 | 7.1 | IMD4 | CA\_n7-n77 | n7 | 2540 | 5 | 25 | 2660 | 7.1 | FDD | IMD4 |
|  | n77 | 3870 | 10 | 50 | 3870 | N/A | N/A |  | n77 | 3870 | 10 | 50 | 3870 | N/A | TDD | N/A |
| DC\_8A\_n1A | 8 | 887.5 | 5 | 25 | 932.5 | N/A | N/A | CA\_n1-n8 | n1 | 1965 | 5 | 25 | 2155 | 6.0 | FDD | IMD4 |
|  | n1 | 1965 | 5 | 25 | 2155 | 6 | IMD4 |  | n8 | 887.5 | 5 | 25 | 932.5 | N/A | FDD | N/A |
| DC\_8A\_n3A | 8 | 900 | 5 | 25 | 945 | 8 | IMD43 | CA\_n3-n8 | n3 | 1755 | 10 | 50 | 1850 | N/A | FDD | N/A |
|  | n3 | 1755 | 10 | 50 | 1850 | N/A | N/A |  | n8 | 900 | 5 | 25 | 945 | 8 | FDD | IMD44 |
|  | 8 | 897.5 | 5 | 25 | 942.5 | N/A | N/A | CA\_n3-n8 | n3 | 1747.5 | 10 | 50 | 1842.5 | 6.4 | FDD | IMD5 |
|  | n3 | 1747.5 | 10 | 50 | 1842.5 | 6.4 | IMD5 |  | n8 | 897.5 | 5 | 25 | 942.5 | N/A | FDD | N/A |
| DC\_8A\_n41A  DC\_8A\_SUL\_n41A-n81A | 8 | 882.5 | 5 | 25 | 927.5 | 12.1 | IMD33 | CA\_n8-n41 | n8 | 882.5 | 5 | 25 | 927.5 | 12.1 | FDD | IMD34 |
|  | n41 | 2685 | 10 | 50 | 2685 | N/A | N/A |  | n41 | 2685 | 10 | 50 | 2685 | N/A | TDD | N/A |
| DC\_8A\_n77A,  DC\_8A\_n78A,  DC\_8B\_n78A  DC\_8A\_n78(2A),  DC\_8A\_n77(3A),  DC\_8A\_SUL\_n78A-n81A | 8 | 897.5 | 5 | 25 | 942.5 | 8.3 | IMD4 | CA\_n8-n78 | n8 | 897.5 | 5 | 25 | 942.5 | 8.3 | FDD | IMD4 |
|  | n77, n78 | 3635 | 10 | 50 | 3635 | N/A | N/A |  | n78 | 3635 | 10 | 50 | 3635 | N/A | TDD | N/A |
| DC\_8A\_n79A,  DC\_8A\_n79C,  DC\_8A\_SUL\_n79A-n81A | 8 | 897.5 | 5 | 25 | 942.5 | 4.8 | IMD5 | CA\_n8-n79 | n8 | 897.5 | 5 | 25 | 942.5 | 4.8 | FDD | IMD5 |
|  | n79 | 4532.5 | 40 | 216 | 4532.5 | N/A | N/A |  | n79 | 4532.5 | 40 | 216 | 4532.5 | N/A | TDD | N/A |
| DC\_12A\_n77A  DC\_12A\_n77(2A) | 12 | 702 | 5 | 20 | 732 | 5.5 | IMD5 | CA\_n12-n77 | n12 | 702 | 5 | 20 | 732 | 5.5 | FDD | IMD5 |
|  | n77 | 3540 | 10 | 50 | 3540 | N/A | N/A |  | n77 | 3540 | 10 | 50 | 3540 | N/A | TDD | N/A |
| DC\_13A\_n77A | 13 | 784.5 | 5 | 20 | 753.5 | 5.5 | IMD5 | CA\_n13-n77 | n13 | 782 | 5 | 20 | 751 | 5.5 | FDD | IMD5 |
|  | n77 | 3891.5 | 10 | 50 | 3891.5 | N/A | N/A |  | n77 | 3880 | 10 | 50 | 3880 | N/A | TDD | N/A |
| DC\_14A\_n5A | 14 | 791 | 5 | 25 | 761 | N/A | N/A | CA\_n5-n14 | n5 | 836 | 5 | 25 | 881 | 25 | FDD | IMD34 |
|  | n5 | 836 | 5 | 25 | 881 | 25 | IMD3 |  | n14 | 791 | 5 | 25 | 761 | N/A | FDD | N/A |
|  | 14 | 795.5 | 5 | 25 | 765.5 | 25 | IMD3 | CA\_n5-n14 | n5 | 826.5 | 5 | 25 | 871.5 | N/A | FDD | N/A |
|  | n5 | 826.5 | 5 | 25 | 871.5 | N/A | N/A |  | n14 | 795.5 | 5 | 25 | 765.5 | 25 | FDD | IMD3 |
| DC\_14A\_n77A  DC\_14A\_n77(2A) | 14 | 795.5 | 5 | 15 | 765.5 | 5.5 | IMD5 | CA\_n14-n77 | n14 | 793 | 5 | 20 | 763 | 5.5 | FDD | IMD5 |
|  | n77 | 3947.5 | 10 | 50 | 3947.5 | N/A | N/A |  | n77 | 3935 | 10 | 50 | 3935 | N/A | TDD | N/A |
| DC\_18A\_n3A | 18 | 823 | 5 | 25 | 868 | N/A | N/A | CA\_n3-n18 | n18 | 818 | 5 | 25 | 863 | N/A | FDD | N/A |
|  | n3 | 1721 | 5 | 25 | 1816 | 4 | IMD4 |  | n3 | 1731 | 5 | 25 | 1826 | 4 | FDD | IMD4 |
| DC\_18A\_n77A  DC\_18A\_n78A | 18 | N/A | N/A | N/A | N/A | N/A | IMD4 | CA\_n18-n779  CA\_n18-n789 | n18 | N/A | N/A | N/A | N/A | N/A | FDD | IMD4 |
|  | n77, n78 | N/A | N/A | N/A | N/A | N/A | N/A |  | n77, n78 | N/A | N/A | N/A | N/A | N/A | TDD | N/A |
| DC\_20A\_n3A | 20 | 840 | 5 | 25 | 799 | N/A | N/A | CA\_n3-n20 | 3 | 1775 | 5 | 25 | 1870 | 4 | FDD | IMD4 |
|  | n3 | 1775 | 5 | 25 | 1870 | 4 | IMD4 |  | 20 | 840 | 5 | 25 | 799 | N/A | FDD | N/A |
|  | 20 | 847 | 5 | 25 | 806 | 9 | IMD4 |  | 3 | 1735 | 5 | 25 | 1830 | N/A | FDD | N/A |
|  | n3 | 1735 | 5 | 25 | 1830 | N/A | N/A |  | 20 | 847 | 5 | 25 | 806 | 9 | FDD | IMD4 |
| DC\_20A\_n77A,  DC\_20A\_n78A  DC\_20A\_n78C7,  DC\_20A\_n78(2A),  DC\_20A\_SUL\_n78A-n82A | 20 | 850 | 5 | 25 | 809 | 11 | IMD4 | CA\_n20-n78 | n20 | 850 | 5 | 25 | 809 | 11 | FDD | IMD4 |
|  | n77, n78 | 3359 | 10 | 50 | 3359 | N/A | N/A |  | n78 | 3359 | 10 | 50 | 3359 | N/A | TDD | N/A |
| DC\_25A\_n77A  DC\_25A-25A\_n77A | 25 | 1855 | 5 | 25 | 1935 | 26 | IMD2 | CA\_n25-n77 | n25 | 1855 | 5 | 25 | 1935 | 26 | FDD | IMD2 |
|  | n77 | 3790 | 10 | 50 | 3790 | N/A | N/A |  | n77 | 3790 | 10 | 50 | 3790 | N/A | TDD | N/A |
|  | 25 | 1900 | 5 | 25 | 1980 | 8 | IMD4 |  | n25 | 1900 | 5 | 25 | 1980 | 8.0 | FDD | IMD4 |
|  | n77 | 3720 | 10 | 50 | 3720 | N/A | N/A |  | n77 | 3690 | 10 | 50 | 3690 | N/A | TDD | N/A |
|  | 25 | 1885 | 5 | 25 | 1965 | 5 | IMD5 |  | n25 | 1885 | 5 | 25 | 1965 | 5 | FDD | IMD5 |
|  | n77 | 3810 | 10 | 50 | 3810 | N/A | N/A |  | n77 | 3790 | 10 | 50 | 3790 | N/A | TDD | N/A |
| DC\_25A\_n78A  DC\_25A-25A\_n78A | 25 | 1855 | 5 | 25 | 1935 | 26 | IMD2 | CA\_n25-n78 | n25 | 1855 | 5 | 25 | 1935 | 26 | FDD | IMD24 |
| n78 | 3790 | 10 | 50 | 3790 | N/A | N/A |  | n78 | 3790 | 10 | 50 | 3790 | N/A | TDD | N/A |
| DC\_28\_n50 | 28 | 730 | 10 | 50 | 775 | 15.3 | IMD 2 | CA\_n28-n50 | n28 | 730 | 10 | 50 | 775 | 15.3 | FDD | IMD2 |
|  | n50 | 1500 | 10 | 50 | 1500 | N/A | N/A |  | n50 | 1500 | 10 | 50 | 1500 | N/A | TDD | N/A |
|  | 28 | 740 | 10 | 50 | 785 | 6 | IMD 4 | CA\_n28-n50 | n28 | 740 | 10 | 50 | 785 | 6.0 | FDD | IMD44 |
|  | n50 | 1500 | 10 | 50 | 1500 | N/A | N/A |  | n50 | 1500 | 10 | 50 | 1500 | N/A | TDD | N/A |
| DC\_26A\_n77A,  DC\_26A\_n78A | 26 | 836.5 | 5 | 25 | 881.5 | 11.1 | IMD4 | CA\_n26-n78 | n26 | 836.5 | 5 | 25 | 881.5 | 11.1 | FDD | IMD4 |
|  | n77, n78 | 3391 | 10 | 50 | 3391 | N/A | N/A |  | n78 | 3391 | 10 | 50 | 3391 | N/A | TDD | N/A |
| DC\_28A\_n77A,  DC\_28A\_n78A,  DC\_28A\_n78(2A),  DC\_28A\_SUL\_n78A-n83A | 28 | 705.5 | 5 | 25 | 760.5 | 5.5 | IMD5 | CA\_n28-n77 | n28 | 705.5 | 5 | 25 | 760.5 | 5.5 | FDD | IMD5 |
|  | n77, n78 | 3582.5 | 10 | 50 | 3582.5 | N/A | N/A |  | n77/n78 | 3582.5 | 10 | 50 | 3582.5 | N/A | TDD | N/A |
| DC\_30A\_n77A  DC\_30A\_n77(2A) | 30 | 2310 | 5 | 25 | 2355 | 8.0 | IMD4 | CA\_n30-n77 | n30 | 2310 | 5 | 25 | 2355 | 8.0 | FDD | IMD4 |
|  | n77 | 3487.5 | 10 | 50 | 3487.5 | N/A | N/A |  | n77 | 3487.5 | 10 | 50 | 3487.5 | N/A | TDD | N/A |
| DC\_38A\_n3A | n3 | 1713 | 5 | 25 | 1808 | 8.2 | IMD4 | CA\_n3-n38 | n3 | 1713 | 5 | 25 | 1808 | 8.2 | FDD | IMD4 |
|  | 38 | 2617 | 5 | 25 | 2617 | N/A | N/A |  | n38 | 2617 | 5 | 25 | 2617 | N/A | TDD | N/A |
| DC\_41A\_n3A  DC\_41C\_n3A | n3 | 1740 | 5 | 25 | 1835 | 8.2 | IMD4 | CA\_n3-n41 | n3 | 1740 | 5 | 25 | 1835 | 8.2 | FDD | IMD4 |
|  | 41 | 2657.5 | 5 | 25 | 2657.5 | N/A | N/A |  | n41 | 2657.5 | 10 | 50 | 2657.5 | N/A | TDD | N/A |
| DC\_48A\_n2A  DC\_48C\_n2A  DC\_48D\_n2A  DC\_48E\_n2A | 48 | 3625 | 20 | 100 | 3625 | N/A | N/A | CA\_n2-n48 | n2 | 1852.5 | 5 | 25 | 1932.5 | 12 | FDD | IMD4 |
|  | n2 | 1852.5 | 5 | 25 | 1932.5 | 12 | IMD4 |  | n48 | 3625 | 20 | 100 | 3625 | N/A | TDD | N/A |
| DC\_48A\_n25A  DC\_48C\_n25A  DC\_48D\_n25A | 48 | 3625 | 20 | 100 | 3625 | N/A | N/A | CA\_n25-n48 | n25 | 1852.5 | 5 | 25 | 1932.5 | 12 | FDD | IMD4 |
|  | n25 | 1852.5 | 5 | 25 | 1932.5 | 12 | IMD4 |  | n48 | 3625 | 20 | 100 | 3625 | N/A | TDD | N/A |
| DC\_48A\_n66A  DC\_48C\_n66A  DC\_48D\_n66A | 48 | 3630 | 20 | 100 | 3630 | N/A | N/A | CA\_n48-n66 | n48 | 3660 | 5 | 25 | 3660 | N/A | TDD | N/A |
|  | n66 | 1715 | 5 | 25 | 2115 | 4 | IMD5 |  | n66 | 1730 | 5 | 25 | 2130 | 5.0 | FDD | IMD5 |
| DC\_66A\_n2A, DC\_66A-66A\_n2A | 66 | 1775 | 5 | 25 | 2175 | N/A | N/A | CA\_n2-n66 | n2 | 1855 | 5 | 25 | 1935 | 20 | FDD | IMD3 |
|  | n2 | 1855 | 5 | 25 | 1935 | 20 | IMD3 |  | n66 | 1775 | 5 | 25 | 2175 | N/A | FDD | N/A |
|  | 66 | 1750 | 5 | 25 | 2150 | 4 | IMD5 | CA\_n2-n66 | n2 | 1883.3 | 5 | 25 | 1963.3 | N/A | FDD | N/A |
|  | n2 | 1883.3 | 5 | 25 | 1963.3 | N/A | N/A |  | n66 | 1750 | 5 | 25 | 2150 | 4 | FDD | IMD5 |
| DC\_66A\_n5A | n5 | 838 | 5 | 25 | 883 | 30 | IMD23 | CA\_n5-n66 | n5 | 838 | 5 | 25 | 883 | 30 | FDD | IMD24 |
|  | 66 | 1721 | 5 | 25 | 2121 | N/A | N/A |  | n66 | 1721 | 5 | 25 | 2121 | N/A | FDD | N/A |
| DC\_66A\_n7A  DC\_66A-66A\_n7A  DC\_66A\_n7(2A)  DC\_66A-66A\_n7(2A) | 66 | 1730 | 5 | 25 | 2130 | N/A | N/A | CA\_n7-n66 | n7 | 2535 | 10 | 50 | 2655 | 15 | FDD | IMD4 |
|  | n7 | 2535 | 10 | 50 | 2655 | 15 | IMD4 |  | n66 | 1730 | 5 | 25 | 2130 | N/A | FDD | N/A |
| DC\_66A\_n25A | 66 | 1775 | 5 | 25 | 2175 | N/A | N/A | CA\_n25-n66 | n66 | 1775 | 5 | 25 | 2175 | N/A | FDD | N/A |
|  | n25 | 1855 | 5 | 25 | 1935 | 20 | IMD3 |  | n25 | 1855 | 5 | 25 | 1935 | 20 | FDD | IMD3 |
|  | 66 | 1712.5 | 5 | 25 | 2112.5 | 23 | IMD3 | CA\_n25-n66 | n66 | 1712.5 | 5 | 25 | 2112.5 | 23 | FDD | IMD3 |
|  | n25 | 1912.5 | 5 | 25 | 1992.5 | N/A | N/A |  | n25 | 1912.5 | 5 | 25 | 1992.5 | N/A | FDD | N/A |
|  | 66 | 1750 | 5 | 25 | 2150 | 4 | IMD5 | CA\_n25-n66 | n66 | 1750 | 5 | 25 | 2150 | 4 | FDD | IMD5 |
|  | n25 | 1883.3 | 5 | 25 | 1963.3 | N/A | N/A |  | n25 | 1883.3 | 5 | 25 | 1963.3 | N/A | FDD | N/A |
| DC\_66A\_n48A | 66 | 1715 | 5 | 25 | 2115 | 4 | IMD5 | CA\_n48-n66 | n48 | 3660 | 5 | 25 | 3660 | N/A | TDD | N/A |
|  | n48 | 3630 | 20 | 100 | 3630 | N/A | N/A |  | n66 | 1730 | 5 | 25 | 2130 | 5.0 | FDD | IMD5 |
| DC\_66A\_n71A | 66 | 1750 | 5 | 25 | 2150 | 5 | IMD4 | CA\_n66-n71 | n66 | 1750 | 5 | 25 | 2150 | 5 | FDD | IMD4 |
|  | n71 | 675 | 5 | 25 | 629 | N/A | N/A |  | n71 | 675 | 5 | 25 | 629 | N/A | FDD | N/A |
| DC\_66A\_n77A  DC\_66A\_n77(2A)  DC\_66A-66A\_n77A  DC\_66A-66A\_n77(2A)  DC\_66A-66A-66A\_n77A  DC\_66A-66A-66A\_n77(2A) | 66 | 1775 | 5 | 25 | 2175 | 31.0 | IMD2 | CA\_n66-n77 | n66 | 1775 | 5 | 25 | 2175 | 31 | FDD | IMD2 |
|  | n77 | 3950 | 10 | 50 | 3950 | N/A | N/A |  | n77 | 3950 | 10 | 50 | 3950 | N/A | TDD | N/A |
|  | 66 | 1760 | 5 | 25 | 2160 | 5.0 | IMD5 | CA\_n66-n77 | n66 | 1760 | 5 | 25 | 2160 | 5.0 | FDD | IMD5 |
|  | n77 | 3720 | 10 | 50 | 3720 | N/A | N/A |  | n77 | 3720 | 10 | 50 | 3720 | N/A | TDD | N/A |
| DC\_66A\_n78A | 66 | 1730 | 5 | 25 | 2150 | 5.0 | IMD5 | CA\_n66-n78 | n66 | 1730 | 5 | 25 | 2130 | 5.0 | FDD | IMD5 |
|  | n78 | 3660 | 10 | 50 | 3660 | N/A | N/A |  | n78 | 3660 | 10 | 50 | 3660 | N/A | TDD | N/A |
| DC\_71A\_n41A | 71 | 666 | 5 | 25 | 620 | 11 | IMD4 | CA\_n41-n71 | n41 | 2614 | 5 | 25 | 2614 | N/A | TDD | N/A |
| n41 | 2618 | 5 | 25 | 2618 | N/A | N/A |  | n71 | 665 | 5 | 25 | 619 | 11 | FDD | IMD4 |
| DC\_71A\_n66A | 71 | 675 | 5 | 25 | 629 | N/A | N/A | CA\_n66-n71 | n66 | 1750 | 5 | 25 | 2150 | 5 | FDD | IMD4 |
|  | n66 | 1750 | 5 | 25 | 2150 | 5 | IMD4 |  | n71 | 675 | 5 | 25 | 629 | N/A | FDD | N/A |
| DC\_71A\_n77A8 | 71 | 671 | 5 | 25 | 625 | 5.5 | IMD5 | CA\_n71-n7713 | n71 | 671 | 5 | 25 | 625 | 5.5 | FDD | IMD5 |
|  | n77 | 3309 | 10 | 50 | 3309 | N/A | N/A |  | n77 | 3309 | 10 | 50 | 3309 | N/A | TDD | N/A |
| DC\_71A\_n78A | 71 | 681.5 | 5 | 25 | 635.5 | 5.5 | IMD5 | CA\_n71-n78 | n71 | 681.5 | 5 | 25 | 635.5 | 5.5 | FDD | IMD5 |
| DC\_71A\_n78(2A) | n78 | 3361.5 | 10 | 50 | 3361.5 | N/A | N/A |  | n78 | 3361.5 | 10 | 50 | 3361.5 | N/A | TDD | N/A |
| NOTE 1: E-UTRA carrier shall be set to min(+20 dBm, PCMAX\_L\_E-UTRA,c) and NR carrier shall be set to min(+20 dBm, PCMAX\_L,f,c,NR) as defined in clause 6.2B.4.1.3.  NOTE 2: RBstart = 0  NOTE 3: This band is subject to IMD5 also which MSD is not specified.  NOTE 4: Void  NOTE 5: Void  NOTE 6: For NR band, UL/DL BW and UL LCRB can be adjusted according to the supported BW and lowest SCS supported by the UE.  NOTE 7: The frequency range in band n28 is restricted for this band combination to 728 - 738 MHz for the UL and 783 - 793 MHz for the DL. This band is subject to IMD2, IMD4 and IMD5 fall in n28 also which MSD is not specified. In addition, this band is subject to IMD4 fall in B21 also which MSD is not specified.  NOTE 8: For a UE which supports this band combination only when the Band n77 frequency range restriction defined in NOTE 12 of Table 5.2-1 from TS 38.101-1 applies, the MSD test point(s) cannot be verified for the band combination and the test point(s) can be skipped. | | | | | | | | NOTE 1: Both of the transmitters shall be set min(+20 dBm, PCMAX\_L,f,c) as defined in clause 6.2A.4  NOTE 2: RBSTART = 0, 15 kHz SCS is assumed.  NOTE 3: No requirements apply when there is at least one individual RE within the intermodulation generated by the dual uplink is within the downlink transmission bandwidth of the FDD band. The reference sensitivity should only be verified when this is not the case (the requirements specified in clause 7.3 apply).  NOTE 4: This band is subject to IMD5 also which MSD is not specified.  NOTE 5: Void.  NOTE 6: Considering the spectrum holdings of the operator for CA\_n77(2A) (when one uplink sub block is assigned within 3300-3400MHz, the other uplink sub block is not assigned within 4000-4200MHz or vice versa), no IMD5 result will fall in Rx frequency range of band n3. Therefore, no MSD requirement apply for this CA configuration when two uplink sub blocks are assigned within CA\_77(2A).  NOTE 7: In current release the maximum separation bandwidth class is 600MHz, therefore, no IMD2 MSD requirement apply for this CA configuration when two uplink sub blocks are assigned within CA\_77(2A).  NOTE8: There is no IMD4/5 products in band n18 downlink for n77 operating in 3520 – 3560 MHz, 3700 – 3800MHz and 4000 - 4100MHz frequency range.  NOTE 9: There is no IMD4 product in band n18 downlink for n78 operating in 3520 – 3560MHz and 3700-3800MHz frequency range.  NOTE 10: There is no IMD4 product in band n24 downlink for n77 operating in 3450 – 3980 MHz and n24 uplink restricted to between 1627.5 – 1637.5 MHz and between 1646.5 – 1656.5 MHz.  NOTE 11: This band is subject to IMD5 also which MSD is not specified..  NOTE 12: This band supports intra-band non-contiguous uplink configuration.  NOTE 13: For a UE which supports this band combination only when the Band n77 frequency range restriction defined in NOTE 12 of Table 5.2-1 applies, the MSD test point(s) cannot be verified for the band combination and the test point(s) can be skipped.  NOTE 14: Applicable when n41 spectrum is restricted to 2515-2675MHz | | | | | | | | |

### 7.3.4 REFSENS requirements without any degradation for inter-band combinations (two bands)

For band combinations DL\_nA-nB\_UL\_nA-nB / DL\_B\_nA\_UL\_B\_nA / DL\_A\_nB\_UL\_A\_nB / DL\_nB\_A\_UL\_nB\_A / DL\_nA\_B\_UL\_nA\_B which doesn’t have any MSD requirements, it’s suggested to test one of them in order to reduce the test burden for REFSENS requirements and final decision is up to RAN5. The reason is that the same Rx RF implementation is used to achieve these band combinations.

For some special cases which have different delta Rib requirements, the requirements specified in clause 7.3A.3.2 from TS 38.101-1 can be reused.

## 7.4 Test burden reduction for multiple MSD

In current RAN4 spec, there are tables for the reference sensitivity exceptions due to intermodulation interference with 2UL CA. The test points in the reference sensitivity requirements specified for the single band are relaxed by the amount of the corresponding MSD values, shown as an example in Table 7.4-1. For some CA configurations such as CA\_n2-n77, CA\_n3-n77 and CA\_n3-n78, multiple test points with different order IMD are defined, while for some other CA configurations such as CA\_n2-n78, only 2nd order IMD2 having the worst case MSD are defined, although the corresponding band is subject to the 5th order IMD5. At the end of the table, a “Note 4” is set to indicate that MSD is not specified for the interfered band although IMD5 may fall into the Rx frequencies of the interfered band. To reduce the test burden, the following guidelines for handling multiple MSD should be taken into consideration.

Table 7.4-1: Example for inter-band reference sensitivity with multiple MSD

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Band / Channel bandwidth / NRB / Duplex mode | | | | | | | | Source of IMD |
| NR CA band combination | NR band | UL Fc  (MHz) | UL/DL BW  (MHz) | UL  CLRB | DL Fc (MHz) | MSD  (dB) | Duplex mode |  |
| CA\_n1-n3 | n1 | 1950 | 5 | 25 | 2140 | 23 | FDD | IMD3 |
|  | n3 | 1760 | 5 | 25 | 1855 | N/A | TDD | N/A |
| CA\_n1-n8 | n1 | 1965 | 5 | 25 | 2155 | 6.0 | FDD | IMD4 |
|  | n8 | 887.5 | 5 | 25 | 932.5 | N/A | FDD | N/A |
| CA\_n1-n78 | n1 | 1950 | 5 | 25 | 2140 | 8.0 | FDD | IMD4 |
|  | n78 | 3710 | 10 | 50 | 3710 | N/A | TDD | N/A |
| CA\_n2-n48 | n2 | 1852.5 | 5 | 25 | 1932.5 | 12 | FDD | IMD4 |
|  | n48 | 3625 | 20 | 100 | 3625 | N/A | TDD | N/A |
| CA\_n2-n77 | n2 | 1855 | 5 | 25 | 1935 | 26 | FDD | IMD2 |
|  | n77 | 3790 | 10 | 50 | 3790 | N/A | TDD | N/A |
|  | n2 | 1900 | 5 | 25 | 1980 | 8.0 | FDD | IMD4 |
|  | n77 | 3720 | 10 | 50 | 3720 | N/A | TDD | N/A |
|  | n2 | 1885 | 5 | 25 | 1965 | 5 | FDD | IMD5 |
|  | n77 | 3810 | 10 | 50 | 3810 | N/A | TDD | N/A |
| CA\_n2-n78 | n2 | 1855 | 5 | 25 | 1935 | 26 | FDD | IMD24 |
|  | n78 | 3790 | 10 | 50 | 3790 | N/A | TDD | N/A |
| CA\_n3-n7 | n3 | 1730 | 5 | 25 | 1825 | N/A | FDD | N/A |
|  | n7 | 2535 | 10 | 50 | 2655 | 10.2 | FDD | IMD4 |
| CA\_n3-n8 | n3 | 1755 | 10 | 50 | 1850 | N/A | FDD | N/A |
|  | n8 | 900 | 5 | 25 | 945 | 8 | FDD | IMD44 |
|  | n3 | 1747.5 | 10 | 50 | 1842.5 | 6.4 | FDD | IMD5 |
|  | n8 | 897.5 | 5 | 25 | 942.5 | N/A | FDD | N/A |
| CA\_n3-n38 | n3 | 1713 | 5 | 25 | 1808 | 8.2 | FDD | IMD4 |
| n38 | 2617 | 5 | 25 | 2617 | N/A | TDD | N/A |
| CA\_n3-n41 | n3 | 1740 | 5 | 25 | 1835 | 8.2 | FDD | IMD4 |
|  | n41 | 2657.5 | 10 | 50 | 2657.5 | N/A | TDD | N/A |
| CA\_n3-n77 | n3 | 1740 | 5 | 25 | 1835 | 26 | FDD | IMD24 |
|  | n77 | 3575 | 10 | 50 | 3575 | N/A | TDD | N/A |
|  | n3 | 1765 | 5 | 25 | 1860 | 8.0 | FDD | IMD44 |
|  | n77 | 3435 | 10 | 50 | 3435 | N/A | TDD | N/A |
| CA\_n3-n78 | n3 | 1740 | 5 | 25 | 1835 | 26 | FDD | IMD24 |
|  | n78 | 3575 | 10 | 25 | 3575 | N/A | TDD | N/A |
|  | n3 | 1765 | 5 | 25 | 1860 | 8.0 | FDD | IMD44 |
|  | n78 | 3435 | 10 | 25 | 3435 | N/A | TDD | N/A |
| … | … | … | … | … | … | … | … | … |
| NOTE 4: This band is subject to IMD5 also which MSD is not specified. | | | | | | | | |

For a given 2 band DL CA combination, MSD test points corresponding to type 1,2,3 UL configuration are captured in the same table entry.

**- Type 1**: UL configuration = 2 UL CCs configured with intra-band UL CA configured in one of the two band. Intra-band UL CA may be contiguous (like UL CA\_n41C) or non-contiguous (like UL CA\_n78(2A)).

**- Type 2**: UL configuration = 2 UL CCs configured inter-band UL CA with 1UL CC in each of UL band. Example: UL CA\_n3A\_n78A.

- **Type 3**: UL configuration = 3 UL CCs with 1 CC in one UL band, and 2 UL CCs configured intra-band CA in the other band. Example: UL CA\_n3A-n41C.

Guideline 1: It is proposed that for the test points with reference sensitivity exceptions due to intermodulation interference with 2UL CA, the limitation to higher order IMD source could be a solution to reduce test burden.

- The existing IMD MSD requirements in Rel-17 specifications are kept unchanged.

- For Rel-18 new introduced band combinations,

– For type 1 UL configurations (e.g. UL\_CA\_n41C or CA\_n78(2A))

- The lowest order IMD is recommended as worst case to represent single band UL transmission with UL configured intra-band CA.

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

- 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.

- As an exception to this rule, a second MSD test point may be specified to capture the MSD that may occur due to the next highest odd order or due to the next highest even order IMD product. This exception ensures regional frequency restrictions are accounted for. For example, in CA\_n66\_n77 the type 1 IMD7 MSD test point (next highest odd order) may be retained in addition to the type 1 IMD5 MSD test point (lowest odd order).

- 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.

- For type 2 UL configurations (e.g. UL\_CA\_n1A-n3A)

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

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, if any, 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 2nd MSD test point corresponds to the lowest even and the lowest odd order IMD. For example, if DL band is affected by IMD2/3/5, we may consider a maximum of test points: one for IMD2 and one for IMD3.

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

- For type 3 UL configurations (e.g. CA\_n3A-n41C or DC\_3C\_n1A-n75A)

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.

If TB frequency is composed of the frequency sum of the 2 discrete RBs in the contiguous UL CA, there is no need to specify the TB test configuration as the requirement can already be verified by the fallback 2UL IMD3. With reference to WF R4-2220556 [9], only the TB1 product |f1+f2-f3| and TB2 product |f1-f2+f3| should be considered – refer to TB landscape example of Figure 7.4-1.

A graph with numbers and lines

Description automatically generated

Figure 7.4-1: Landscape of 1st order triple beat products for the example of DC\_3C\_n1A-n75A

*-* If TB consists of intra-band contiguous UL CA in a FDD band, the selection of test configuration should strive to avoid FDD band self-interference to its own DL carriers with at least up to IMD7.

*-* The following WF [9] guidelines remain applicable:

- 2.1 WF on Pre-Condition for TB MSD Analysis with 3UL CCs

*-* 2.2 WF on Pre-Condition for TB MSD Analysis with 4UL CCs

*-* 2.3 WF on Triple-Beat Detection for two-band combinations

*-* 2.5 WF on MSD analysis

- 2.6 WF on Capturing MSD Test Points

# 8 Conclusion

Compared with previous generations, 5G NR has much more complex band combination configurations being specified. The study item handles the simplification of band combination and rule collection for RAN4 specifications in the stage of Rel-18. The key functionalities of this SI mainly include the following aspects.

- To keep a TR running with all the valid rules and valuable guidelines for band combinations being captured, the related contents in Rel-17 TR 38.862 are transited in this TR.

- The working procedure for specifying band combinations including templates for specifying band combinations, fallback aspects for specifying band combinations and submitting technical contributions for specifying band combinations have been proposed.

- Guidelines of specifying band combinations on fallbacks, delta TIB/RIB, configuration table structure, co-existence analysis and simplification for MSD due to IMD interference, etc. have been studied.

- To include 2UL inter-band CA/DC coexistence reduction, FR1 CA/DC, FR1 EN-DC/NE-DC and LTE CA cases are agreed to be applied to NR/LTE specifications.

- The dependency and applicability for RF requirements among different features for the same spectrum combination to reduce the redundant tests have been analysed.

- The guidelines for test burden reduction for harmonic mixing, cross-band isolation MSD and inter-modulation distortion for inter-band combinations have been investigated.

Annex A (informative):  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Change history | | | | | | | |
| Date | Meeting | TDoc | CR | Rev | Cat | Subject/Comment | New version |
| 2022-08 | RAN4 #104-e | R4-2215080 |  |  |  | 1. R4-2215080, TR skeleton, ZTE | 0.0.1 |
| 2022-10 | RAN4 #104-bis-e | R4-2216616 |  |  |  | 1. R4-2216620, TP for TR 38.846 on rules of delta TIB and RIB due to band combinations, ZTE  2. R4-2217719, TP for TR38.846\_Update template for R18 PC3 basket WIDs, ZTE  3. R4-2217720, TP on test burden reduction, Huawei, HiSilicon  4. R4-2217721, Fallbacks in 38.101 specs, Apple  5. R4-2217722, TP for TR 38.846 on working procedure of specifying band combinations, ZTE | 0.1.0 |
| 2022-11 | RAN4 #105 | R4-2219762 |  |  |  | 1. R4-2220510, TP for TR 38.846 to capture some agreements for REFSENS test burden reduction, Huawei, HiSilicon  2. R4-2220511, TP for TR 38.846 on test burden reduction for multiple MSD in band combinations, ZTE Corporation  3. R4-2219626, TP for TR 38.846 to capture the fallback rules with exceptional cases, Huawei, HiSilicon  4. R4-2219759, TP for TR 38.846 on templates of delta TIB and RIB for NE-DC and SUL band combinations, ZTE Corporation | 0.2.0 |
| 2023-03 | RAN4 #106 | R4-2302551 |  |  |  | 1. R4-2303512, TP for TR 38.846 on template for mixed intra-band contiguous and non-contiguous NR CA, ZTE  2. R4-2303543, Updates of template for R18 PC3 ENDC NRCA SUL V2X band combinations, ZTE  3. R4-2303513, TP for TR 38.846 on simplification for CA uplink configurations, ZTE  4. R4-2303514, TP for TR 38.846 to capture some agreements for MSD test burden reduction, Huawei, HiSilicon  5. R4-2203515, TP for TR 38.846 to add guidance on document type for addition of band combinations, Nokia | 0.3.0 |
| 2023-04 | RAN4 #106bis-e | R4-2304726 |  |  |  | 1. R4-2306585, TP for TR 38.846 on valid CBW for higher order BC configurations, ZTE  2. R4-2306586, TP for TR 38.846 on template for R18 HPUE band combination, ZTE  3. R4-2306587, Template for R18 HPUE band combinations, ZTE  4. R4-2306588, TP for TR 38.846 on test burden reduction for multiple MSD in band combinations, Skyworks Solutions, Inc. | 0.4.0 |
| 2023-05 | RAN4 #107 | R4-2307981 |  |  |  | 1. R4-2307985, Template v1.2 for R18 PC3 ENDC NRCA SUL V2X band combinations, ZTE  2. R4-2307986, TP for TR 38.846 on update template info for R18 PC3 and HPUE band combination, ZTE  3. R4-2310274, TP to TR 38.846 to add guidance on Co-existence studies for Uplink Intra-Band Non-Contiguous CA, Nokia, Nokia Shanghai Bell, Skyworks Solutions, Inc.  4. R4-2307867, 2UL UE to UE co-ex simplification for EN-DC, Nokia  5. R4-2309715, TP for 38.846: HPUE for FR1+FR2 band combinations, T-Mobile USA, Ericsson, Nokia, AT&T, Verizon, Skyworks Solutions, Inc. | 0.5.0 |
| 2023-06 | RP#100 | RP-231290 |  |  |  | 1. RP-231290, TR 38.846 v1.0.0\_Study on simplification of band combination specification for NR and LTE, ZTE | 1.0.0 |
| 2023-09 | RAN4#108 | R4-2312595 |  |  |  | 1. R4-2311928, TP for TR 38.846 Update the rule on the fallback information aspect for specifying band combinations, Samsung, CHTTL, ZTE  2. R4-2314684, TP for TR 38.846\_Capture the valid rules and guidelines of TR 38.862 into TR 38.846, ZTE, CHTTL  3. R4-2314685, TP for TR 38.846 on test burden reduction for type 3 TB MSD, Skyworks Solutions Inc.  4. R4-2314686, TP for TR 38.846 guidelines on simplification for 3DL2UL MSD, Skyworks Solutions Inc. | 1.1.0 |
| 2023-10 | RAN4#108bis | R4-2316679 |  |  |  | 1. R4-2316686, TP for FS\_SimBC on TR 38.846 cleanup, ZTE  2. R4-2316687, TP for TR 38.846\_Restructure the clause for optimization on band combinations, ZTE, CHTTL  3. R4-2316436, TP for TR 38.846 about that BCS4 and BCS5 channel BW does not need to be specified in BCS sheet, Ericsson  4. R4-2316689, TP for TR 38.846\_Guidelines on delta TIB and RIB special values for band combinations, ZTE, CHTTL | 1.3.0 |
| 2023-11 | RAN4#109 | R4-2319604 |  |  |  | 1. R4-2320998, TP for TR 38.846 Guidelines on Cross-band MSD test points for SUL, Skyworks  2. R4-2320999, TP for TR38.846 Guidelines on Cross-band MSD with FDD UL-CA, Skyworks  3. R4-2321794, TP for TR 38.846: On bandwidth classes for NR band combinations, ZTE  4. R4-2321795, TP to TR38.846 of Guidelines on Co-existence analysis for triple beat, Nokia, Nokia Shanghai Bell  5. R4-2321796, TP to TR 38.846 Addition of Guidelines on Harmonic mixing MSD requirements, Nokia, Nokia Shanghai Bell  6. R4-2321921, TP for TR 38.846: On spec structure for inter-band CA configuration tables, ZTE | 1.4.0 |
| 2023-12 | RAN#102 | RP-233235 |  |  |  | 1. RP-233235, Presentation of TR 38.846 to TSG#102, ZTE | 2.0.0 |

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