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Contents

Foreword

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

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1 Scope

The purpose of this report is to summarize studies of radio requirements for the Base Station (BS) and User Equipment (UE) radio transmission and reception as part of the Rel-11 work on LTE Carrier Aggregation Enhancements.

2 References

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

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

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

[2] 3GPP TR 30.007: "Guideline on WI/SI for new Operating Bands"

3 Definitions, symbols and abbreviations

3.1 Definitions

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.

Contiguous spectrum: Spectrum consisting of a contiguous block of spectrum with no sub-block gaps.

Lower sub-block edge: The frequency at the lower edge of one sub-block. It is used as a frequency reference point for both transmitter and receiver requirements.

Non-contiguous spectrum: Spectrum consisting of two or more sub-blocks separated by sub-block gap(s).

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.

Sub-block bandwidth: The bandwidth of one sub-block.

Sub-block gap: A frequency gap between two consecutive sub-blocks within an RF bandwidth, where the RF requirements in the gap are based on co-existence for un-coordinated operation.

Upper sub-block edge: The frequency at the upper edge of one sub-block. It is used as a frequency reference point for both transmitter and receiver requirements.

3.2 Symbols

$BW_{Channel,block}$ Sub-block bandwidth, expressed in MHz. $BW_{Channel,block} = F_{edge,block,high} - F_{edge,block,low}$.
$F_{C,block,high}$ Center frequency of the highest transmitted/received carrier in a sub-block.
$F_{C,block,low}$ Center frequency of the lowest transmitted/received carrier in a sub-block.
$F_{edge,block,high}$ The upper sub-block edge, where $F_{edge,block,high} = F_{C,block,high} + F_{offset}$.
$F_{edge,block,low}$ The lower sub-block edge, where $F_{edge,block,low} = F_{C,block,low} - F_{offset}$.
$F_{offset,block,high}$ Separation between higher edge of a sub-block and the center of the highest component carrier within the sub-block

$F_{offset,block,low}$ Separation between lower edge of a sub-block and the center of the lowest component carrier within the sub-block

W_{gap} Sub-block gap size

4 Background

This report contains information related to general framework for Carrier Aggregation enhancements covering

- UE and BS aspects;
- intra-band non-contiguous spectrum.

CA specific Intra band combinations are treated under the separate Work Items. Those studies are captured in separate Technical Reports.

4.1 Task description

The work should fulfil the following objectives:

- Specify the support of the use of multiple timing advances in case of LTE uplink carrier aggregation;
- Define generic framework for UE and BS core requirements for non-contiguous intra-band carrier aggregation in RAN WG4 based on the existing RAN WG1, RAN WG2, and RAN WG3 specifications;
- Study additional carrier types including non-backwards compatible elements for Carrier Aggregation. A way forward for additional carrier types and related details will be decided based on trade-off analyses where deployment scenarios, benefits, drawbacks and work item time line are carefully considered from the perspectives of all the RAN WGs;
- Identify the impact to UE and eNB specifications.

5 Multiple timing advances

The timing advance group (TAG) is introduced in Rel-11 for supporting multiple timing advances for some carrier aggregation scenarios. A TAG includes one or more serving cells with the same UL timing advance and the same DL timing reference cell. If a TAG contains the PCell, it is named as Primary Timing Advance Group (pTAG). If a TAG contains only SCell(s), it is named as Secondary Timing Advance Group (sTAG). There is one timing reference cell and one time alignment timer (TAT) per TAG and each TAT may be configured with a different value. For pTAG, PCell is used as the timing reference cell. For sTAG, UE may use any activated SCell from the same sTAG as timing reference cell.

From RF requirement point of view, the number of CA component carrier is limited to 2 for Rel-11. Thus, TS 36.133 will support only up to 2 TAGs for Rel-11. If the sTAG is configured, there is only one cell, i.e., SCell, in the sTAG.

With respect to timing advance maintenance of the sTAG, the initial UL time alignment of sTAG is obtained by an eNB initiated random access procedure similar to pTAG. The SCell in an sTAG can be configured with RACH resources and the eNB may order RACH access on the SCell. The Msg2 in response to an SCell preamble is transmitted on the PCell using RA-RNTI that conforms to Rel-8. Grant in Msg2 is valid for the SCell in which the preamble was transmitted. UE stops RA preamble transmission on an SCell when reaching PREAMBLE_TRANS_MAX (failure case). However, the UE will not indicate a Random Access problem to upper layers if the maximum number of preamble transmission counter has been reached for the random access procedure on SCell.

The UE shall track the downlink frame timing change of SCell and adjust UL transmission timing following the timing advance commands from the eNB. The same performance requirements of the timing advance maintenance of the pTAG shall also to the timing advance maintenance of the sTAG.

For inter-band carrier aggregation with two uplink serving cells assigned to different timing advance groups (TAGs) and there is an overlap in the UL timing of adjacent subframes of active serving cells in the different TAGs (Figure 5-

1), $P_{PowerClass}$ shall not be exceeded by the UE during any period of time and $P_{CMAX,c}$ and P_{CMAX} for the overlap time shall be determined by the UE as follows:

- $P_{CMAX,c}$ for serving cell c in each subframe shall be set by the UE as if the overlap did not exist and shall be applicable to the entire subframe including the overlap time.

- P_{CMAX} for the overlap time shall be set by the UE within the bounds allowed for P_{CMAX} of one of the adjacent subframes, specifically the one with the lower allowed $P_{CMAX\_L\_CA}$.

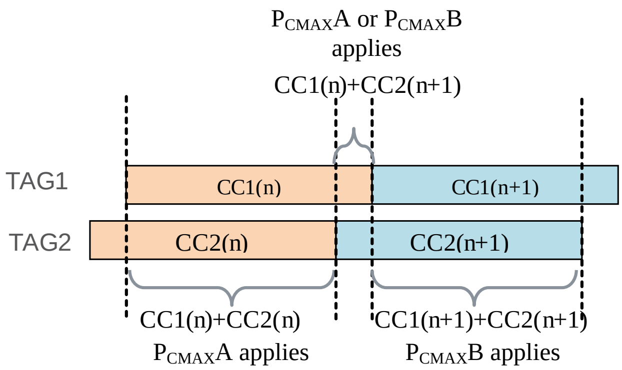


Figure 5-1:

6 Intra-band non-contiguous CA

6.1 BS characteristics

Carrier Aggregation Enhancement Work Item specified BS requirements for intra-band non-contiguous operation for E-UTRA. Requirements are based on the MSR specification 37.104 which specifies BS non-contiguous operation from Rel'10. The following changes were made in 36.104 in order to support intra-band non-contiguous operation:

- Introduction of new definitions, symbols and abbreviations

- Introduction of new table on intra-band non-contiguous carrier aggregation bands

- Introduction of definition of sub-block bandwidth for intra-band non-contiguous spectrum

- Clarification on requirements for contiguous and non-contiguous spectrum

- Introduction of Time Alignment Error requirement for intra-band non-contiguous operation

- Clarification of occupied bandwidth and ACLR requirements for non-contiguous spectrum

- Introduction of Cumulative ACLR (CACLR) requirement for intra-band non-contiguous operation

- Clarification of operating band unwanted emissions and transmitter intermodulation requirements for non-contiguous spectrum

- Clarification of ACS, narrowband blocking, blocking and receiver intermodulation requirements for non-contiguous spectrum

6.2 UE characteristics

6.2.1 General

Carrier aggregation enhancement WI will develop UE requirements for DL and UL non-contiguous intraband carrier aggregation using band 25 as en example FDD band and band 41 as an example TDD band.

6.2.1.1 Derivation of non-contiguous intraband CA configuration acronym

The CA configuration acronym tells what are the UE capabilities for simultaneous reception or transmission in terms of E-UTRA operating bands and channel bandwidths/aggregated channel bandwidths. This information is signalled to network separately for DL and UL.

As an example the acronym for the non-contiguous intraband CA for band 25 is CA_25A-25A. This acronym tells that UE is able to receive or transmit simultaneously two separate carriers on band 25.

The individually received/transmitted RF-blocks are called sub-blocks for non-contiguous intraband CA thus the letters in non-contiguous intraband CA acronym refers to sub-blocks. In REL-11 time frame sub-block equals one carrier. In future releases it can be that there are operator deployment scenarios where a single carrier is combined to intraband contiguous BW class C signal within a single band. CA configuration acronym for this kind of signal could be for-example CA_25A-25C.

In Figure 6.21.1-1 we present the methodology how to derive the CA configuration acronyms for the three different CA schemes currently defined in 3GPP.

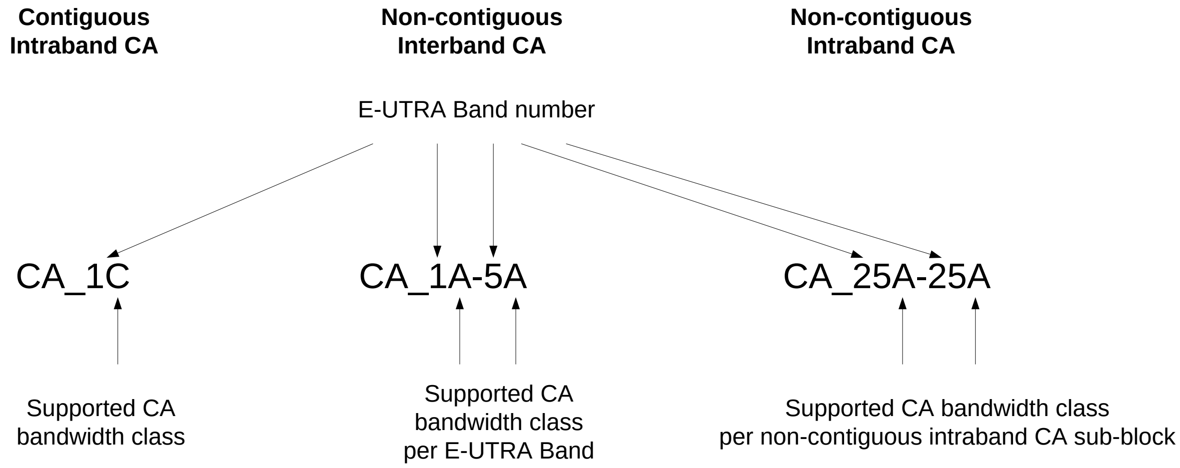


Figure 6.2.1.1-1: How to derive CA configuration acronym for different carrier aggregation schemes

6.2.1.2 Channel bandwidth for non-contiguous intraband CA

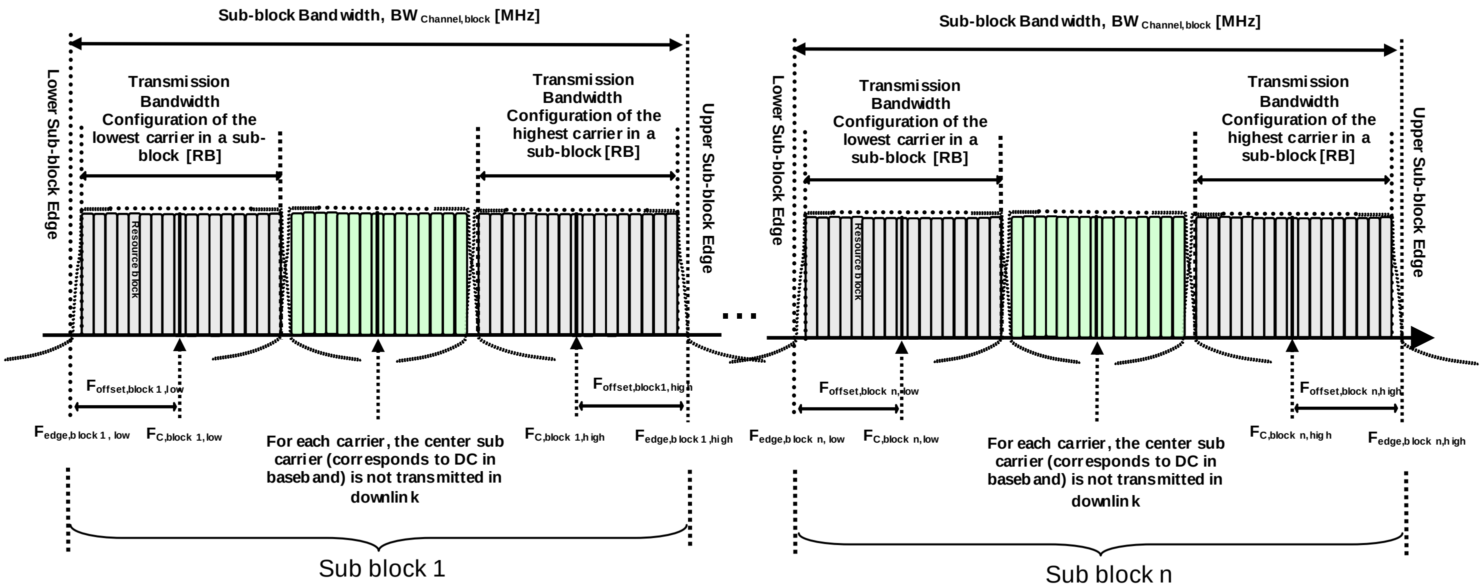


Figure 6.2.1.2-1: Non-contiguous intraband CA terms and definitions

The lower sub-block edge of the Sub-block Bandwidth ($BW_{Channel,block}$) is defined as $F_{edge,block,low} = F_{C,block,low} - F_{offset,block,low}$. The upper sub-block edge of the Sub-block Bandwidth is defined as $F_{edge,block,high} = F_{C,block,high} + F_{offset,block,high}$. The Sub-block Bandwidth, $BW_{Channel,block}$, is defined as follows:

$$BW_{Channel,block} = F_{edge,block,high} - F_{edge,block,low} \text{ [MHz]}$$

The lower and upper frequency offsets $F_{offset,block,low}$ and $F_{offset,block,high}$ depend on the transmission bandwidth configurations of the lowest and highest assigned edge component carriers within a sub-block and are defined as

$$F_{offset,block,low} = 0.18N_{RB,low}/2 + BW_{GB} \text{ [MHz]}$$

$$F_{offset,block,high} = 0.18N_{RB,high}/2 + BW_{GB} \text{ [MHz]}$$

where $N_{RB,low}$ and $N_{RB,high}$ are the transmission bandwidth configurations according to Table 5.6-1 for the lowest and highest assigned component carrier within a sub-block, respectively. BW_{GB} denotes the *Nominal Guard Band* and is defined in Table 6.2.1.2-1, and the factor 0.18 is the PRB bandwidth in MHz.

Table 6.2.1.2-1: CA bandwidth classes and corresponding nominal guard bands

CA Bandwidth Class	Aggregated Transmission Bandwidth Configuration	Maximum number of CC	Nominal Guard Band BW_{GB}
A	$N_{RB,agg} \le 100$	1	$0.05BW_{Channel(1)}$
B	$N_{RB,agg} \le 100$	2	FFS
C	$100 < N_{RB,agg} \le 200$	2	$0.05\ max(BW_{Channel(1)},BW_{Channel(2)})$
D	$200 < N_{RB,agg} \le$ [300]	FFS	FFS
E	[300] $< N_{RB,agg} \le$ [400]	FFS	FFS
F	[400] $< N_{RB,agg} \le$ [500]	FFS	FFS
NOTE 1: $BW_{Channel(1)}$ and $BW_{Channel(2)}$ are channel bandwidths of two E-UTRA component carriers according to Table 5.6-1.			

6.2.2 Transmitter characteristics

6.2.2.1 Reference transmitter architecture

Transmitter architecture presented in Figure 6.2.2.1-1 will be used when specifying the non-contiguous intraband CA transmitter characteristic, for example required MPR to meet the emission requirements.

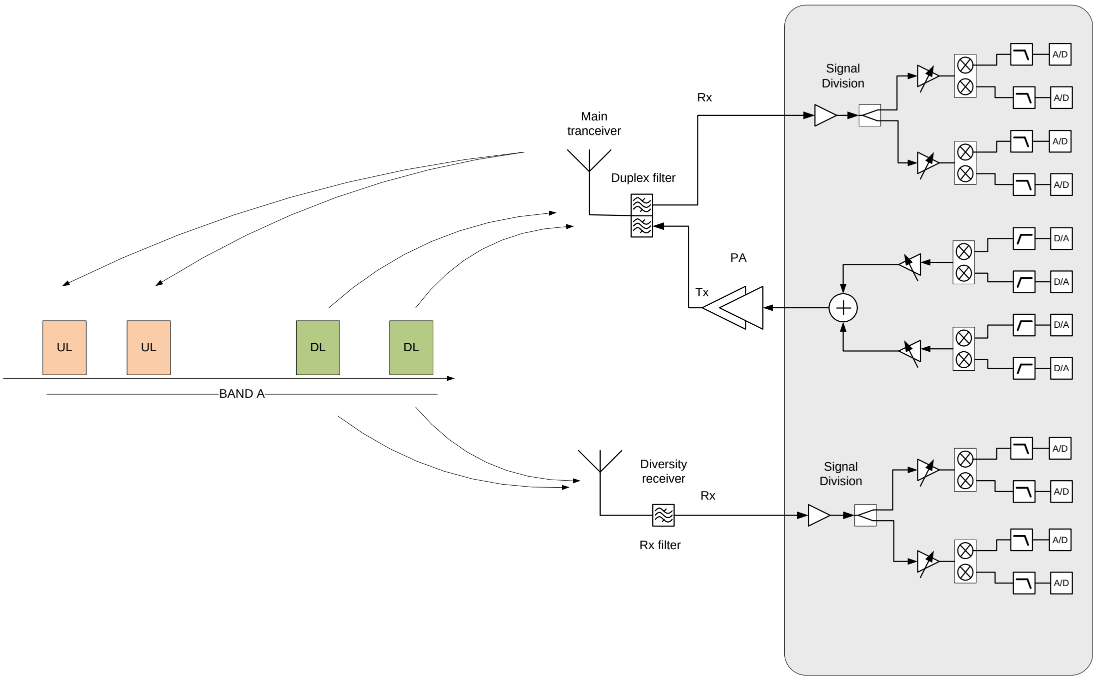


Figure 6.2.2.1-1: Non-contiguous intraband CA reference transmitter architecture

6.2.2.2 Unwanted emissions

Composite emission requirement is the emission requirement for non-contiguous intraband CA transmission when the transmission consists of multiple sub-blocks. It shall be derived with following procedure.

- As a basis Individual sublocks will follow single E-UTRA carrier SEM (and spurious emission requirements)
- When spurious emission domain of CC1 falls into OOB domain of CC2 or vice versa it is not taken into account (in practice always lower than SEM)
- If two SEMs overlap then the SEM which allows higher PSD for emissions is selected
- If SEM or spurious emission requirement of CC1 overlaps the channel bandwidth of CC2 or vice versa it is not taken into account.

As an example composite emission requirement is determined for various signals. Results are presented in a form as in Figure 6.2.2.2-1 where first applicable SEM and spurious emission requirements for both CC's are drawn. SEM's are drawn in black and spurious emission requirements in blue and both are associated with a number which indicates to which CC they are applicable. Then in the lower figure the composite emission requirement is derived following the rules listed above.

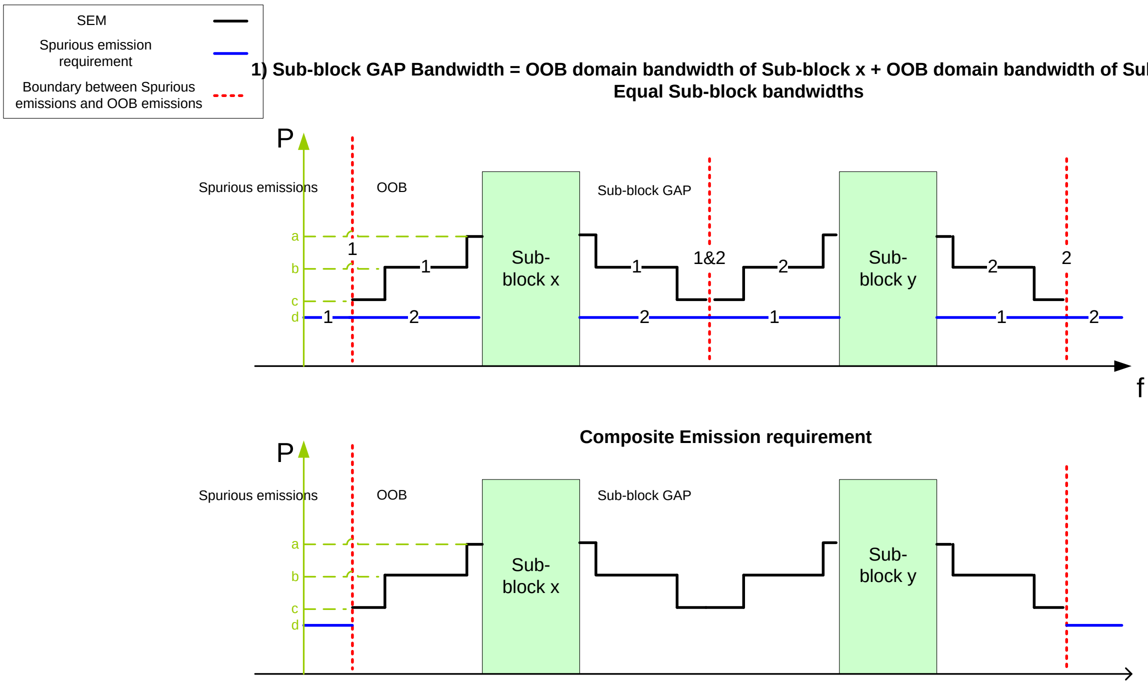


Figure 6.2.2.2-1: Derivation of composite emission requirement

In the Figure 6.2.2.2-2 same study is repeated for cases where the sub-block gap size is varied. Following cases where examined

- Sub-block gap bandwidth = OOB domain bandwidth of CC1 + OOB domain bandwidth of CC2 (Figure 6.2.2.2-1)
- Sub-block gap bandwidth > OOB domain bandwidth of CC1 + OOB domain bandwidth of CC2
- Sub-block gap bandwidth < OOB domain bandwidth of CC1 + OOB domain bandwidth of CC2
- Sub-block gap bandwidth < MIN(OOB domain bandwidth of CC1, OOB domain bandwidth of CC2)

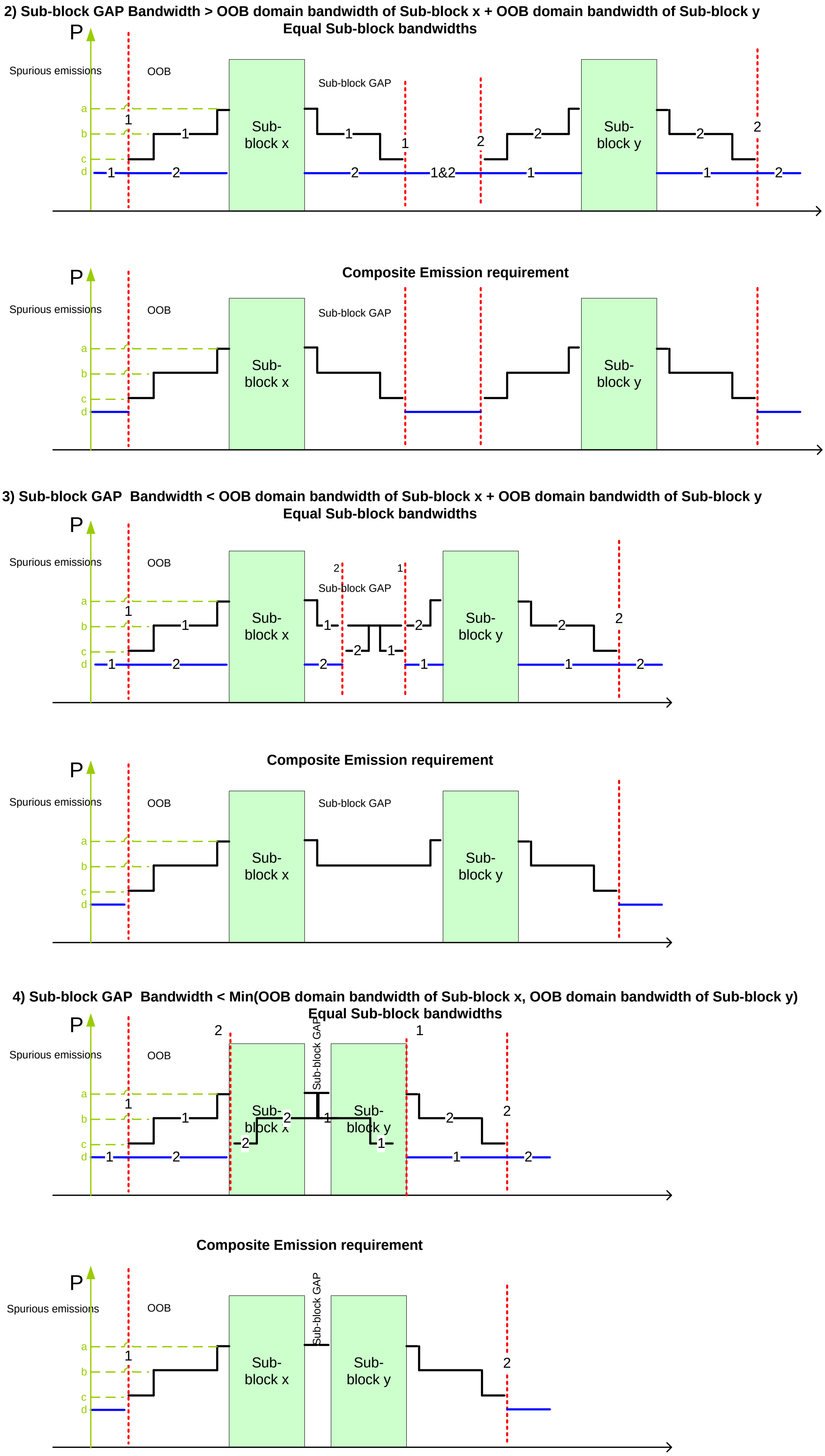


Figure 6.2.2.2-2: Study of different sub-block gap sizes

The case where the CC's had different bandwidths is also studied. In Figure 6.2.2.2-3 presents the case which does not occur with equal CC bandwidths i.e. the OOB region of wider CC extends over the narrower CC.

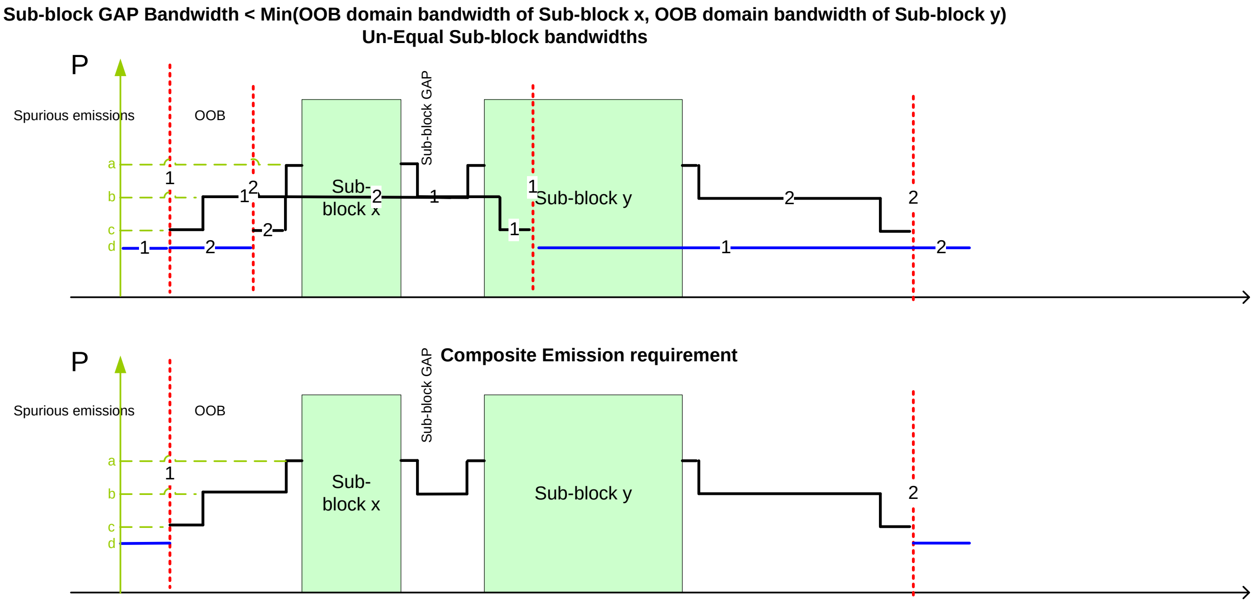


Figure 6.2.2.2-3: Case where OOB region of wider sub-block extends over narrower sub-block.

Agreement: Use composite emission requirement for non-contiguous intraband CA transmissions. Composite emission requirement is derived by following these rules.

1. Each non-contiguous intraband CA sublock emission shall follow single carrier SEM and spurious emission requirements as defined in sub clauses 6.6.2 and 6.6.3 in TS36.101
2. When spurious emission domain of sub-block x falls into OOB domain of sub-block y or vice versa it is omitted
3. If SEMs overlap then the SEM which allows higher PSD for emissions is selected

If SEM or spurious emission requirement of sub-block x overlaps the channel bandwidth of sub-block y or vice versa it is omitted

6.2.2.3 ACLR

In Figure 6.2.2.3-1 we compare how much the absolute emissions would be from UE if the ACLR requrments would be set as proposed in R4-122735 and R4-122522. In addition we have drawn a picture presenting the current single carrier transmissions case. There we have examined E-UTRA ACLR where the adjacent channel measurement bandwidth is same as the sub-block bandwidth next to it.

For single carrier E-UTRA UE the maximum allowed emissions to adjacent channel is +23 dBm – 30 dB = - 7 dBm (we have not taken into account the MPR as it is not mandatory). According to proposal in R4-122735 for the case where sub-blocks have equal bandwidth (and PSD) the interference power into to adjacent channel would be – 10 dBm, if the other sub-block would have smaller bandwidth the sub-block being tested would have higher power than 20 dBm and thus the interference to adjacent channel would be more than – 10 dBm but still less than – 7 dBm which was the single carrier reference. According to proposal R4-122522 the adjacent channel interference power would be – 7 dBm which is same as for reference single carrier case. The interference power would not change if relative sub-block bandwidths change as reference power is the sum of sub-block powers.

As can be seen both proposal would produce ALCR emissions which are equal or less than single carrier operation would produce and in that sense are acceptable. Also we want to point out that it is evident from R4-121205 that RAN4 needs to specify MPR for non-contiguous intraband case which is more than the MPR for single carrier case thus emissions for non-contiguous case for adjacent channel will be smaller as the ACLR requirement is relative to transmission power.

Proposal from R4-122522 is selected as it gives constant maximum absolute interference power to adjacent channel even if carriers in sub-blocks are not fully populated or have un-equal bandwidths.

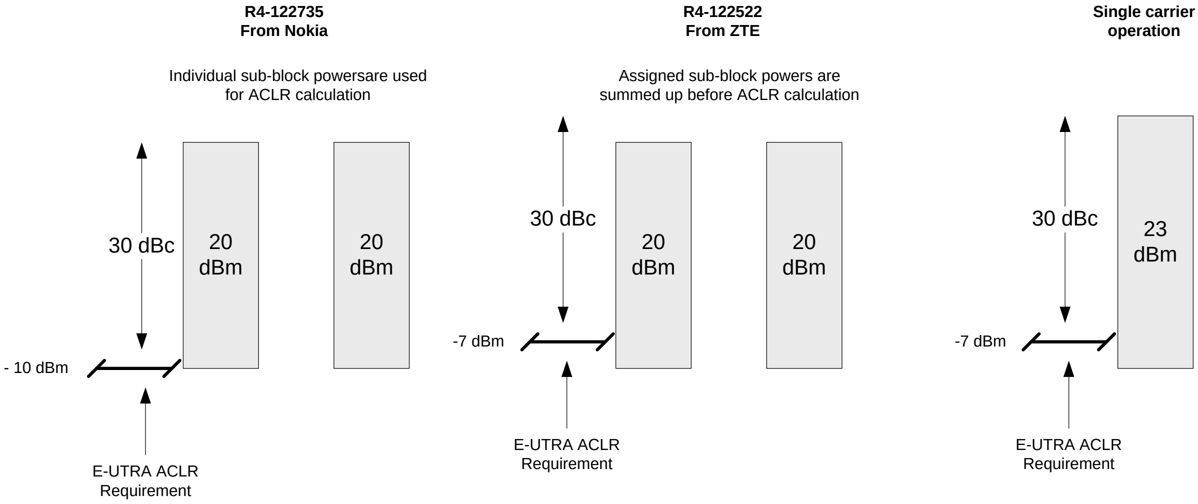


Figure 6.2.2.3-1: Absolute emission levels due to ACLR

Following UE ACLR definition for non-contiguous intraband CA is agreed

- **Proposal 1: Adjacent channel leakage ratio for non-contiguous intraband CA is defined as a ratio of**
    - **The sum of the filtered mean powers centered on the assigned channel frequencies and**
    - **The filtered mean power centered on a frequency channel adjacent to one of the respective sub-block edges**

For single carrier case RAN4 has set requirements for $UTRA_{ACLR1}$, $UTRA_{ACLR2}$ and E- $UTRA_{ACLR1}$. For contiguous intraband CA requirements are set for $UTRA_{ACLR1}$, $UTRA_{ACLR2}$ and CA E- $UTRA_{ACLR1}$.

Figure 6.2.2.3-2 sketches the situation where non-contiguous intraband CA ACLR requirements are set similarly as it has done for single carrier i.e. $UTRA_{ACLR1}$, $UTRA_{ACLR2}$ and E- $UTRA_{ACLR1}$ with the exception that both sub-blocks have own requirements set. As can been seen the number of ACLR requirements varies between 6 -12 depending on the gap size.

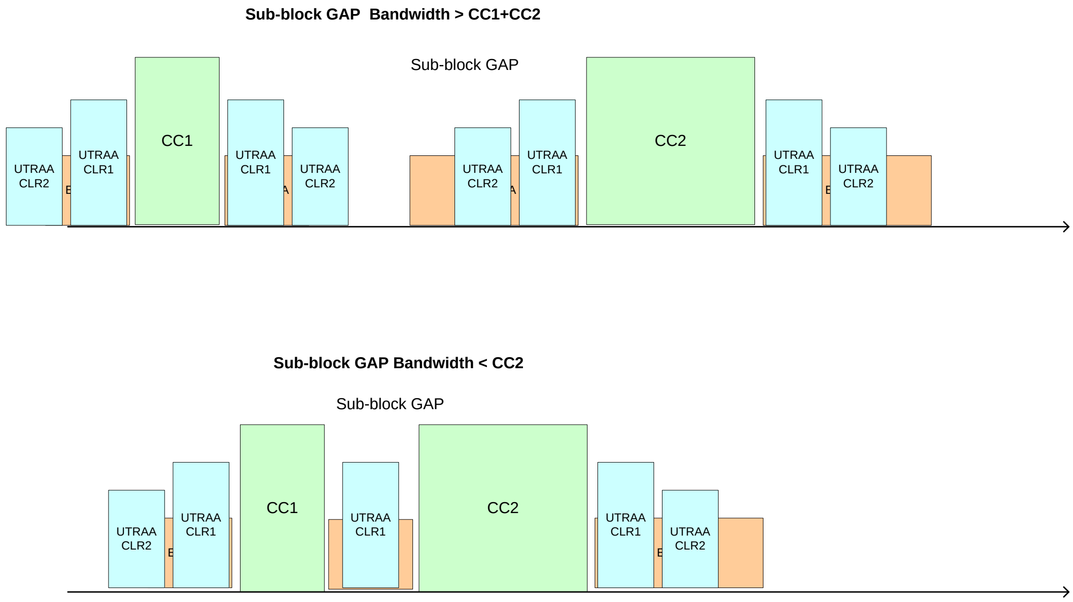


Figure 6.2.2.3-2: Different ACLR requirements

In order to ensure good co-existence with legacy systems following UE ACLR requirements for non-contiguous intraband CA are agreed

- **Proposal 2: $UTRA_{ACLR1}$, $UTRA_{ACLR2}$ and E- $UTRA_{ACLR1}$ requirements are set for all non-contiguous intraband CA sub-blocks**

- **Proposal 3: $UTRA_{ACLR1}$ = 33 dB, $UTRA_{ACLR2}$ = 36 dB E- $UTRA_{ACLR1}$ = 30 dB**

Following additional definitions are agreed for UE non-contiguous intraband CA ACLR to accommodate varying gap size in requirement setting.

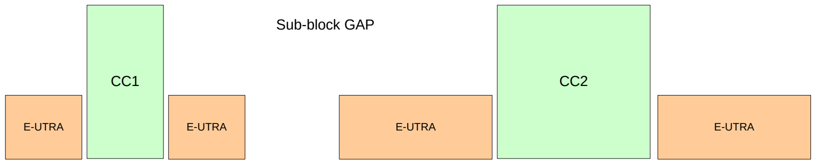
- **Proposal 4: $UTRA_{ACLR1}$ and $UTRA_{ACLR2}$**
  - **$UTRA_{ACLR1}$ is required to be met in the sub-block gap when the gap bandwidth W_{gap} is $5MHz \le W_{gap} < 15 MHz$.**
  - **Both $UTRA_{ACLR1}$, $UTRA_{ACLR2}$ are required to be met in the sub-block gap when the gap bandwidth W_{gap} is $15MHz \le W_{gap}$**

In case sub-blocks have different bandwidths for the E-$UTRA_{ACLR}$ (see Figure 6.2.2.3-3) it is proposed that E-$UTRA_{ACLR1}$ adjacent channel power measurement bandwidth equals the sub-block bandwidth is is adjacent to.

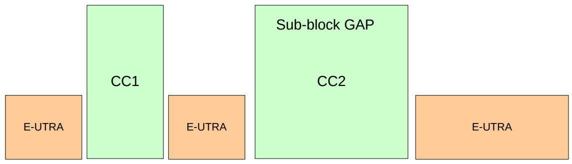
In case the sub-block gap is smaller than other of the sub-blocks then for that sub-block no E-$UTRA_{ACLR}$ requirement is set to the gap. $W_{gap} < BW_{Channel,block(1)}$ or $W_{gap} < BW_{Channel,block(2)}$).

In case the gab bandwidth is smaller than either of the sub-block bandwidths then no E- $UTRA_{ACLR1}$ requirement is set for the gap. $W_{gap} < \min(BW_{Channel,block(1)}, BW_{Channel,block(2)})$

$W_{gap} < BW_{Channel,block(1)} + BW_{Channel,block(2)}$.



$W_{gap} < BW_{Channel,block(1)}$ or $W_{gap} < BW_{Channel,block(2)}$.



$W_{gap} < \min (BW_{Channel,block(1)}, BW_{Channel,block(2)})$

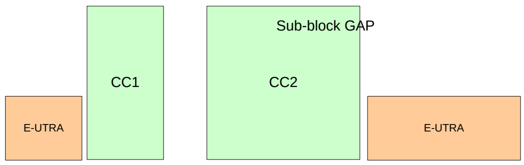


Figure 6.2.2.3-3: E-UTRA$_{ACLR}$ in case of unequal subblock bandwidth

- **Proposal 5: For E-UTRA$_{ACLR}$**
  - **E- UTRA$_{ACLR1}$ adjacent channel power measurement bandwidth equals the sub-block bandwidth that it is adjacent to.**
  - **In case the sub-block gap is smaller than other of the sub-blocks then for that sub-block no E-UTRA$_{ACLR}$ requirement is set for the gap.**
  - **In case the gab bandwidth is smaller than either of the sub-block bandwidths then no E- UTRA$_{ACLR1}$ requirement is set for the gap.**

To see how much MPR is required to meet the ACLR requirements proposed in this clause a simulation campaign was performed where six different NC-intraband CA signals with four different sub-block gap sizes were examined. Results are presented in Table 6.2.2.3-1. The reference transmitter architecture used in this study was the single PA version also referred as Tx architecture 1 in R4-114901. Transmitted signal was consisting of fully populated sub-blocks which had equal PSD.

Table 6.2.2.3-1: Required MPR

Non-contiguous CA: Required backoff with full allocations					
Bandwidth	**Gap width (MHz)**	**Backoff (dB)**	**Gating factor**	**Backoff (dB), due to ACLR only**	**Gating factor**
100+100	5	3.53	Spur	1.91	EUTRA ACLR
	10	3.82	Spur	1.57	EUTRA ACLR
	20	3.88	Spur	1.07	Gap EUTRA ACLR
	40	3.87	Spur	-	-
75+75	5	3.86	Spur	1.98	UTRA ACLR2
	10	4.18	Spur	1.25	EUTRA ACLR
	20	4.18	Spur	0.14	Gap EUTRA ACLR
	40	4.20	Spur	0.06	UTRA ACLR1
100+50	5	4.05	Spur	2.19	EUTRA ACLR
	10	3.92	Spur	2.01	EUTRA ACLR
	20	4.08	Spur	1.44	Gap EUTRA ACLR
	40	4.09	Spur	1.12	UTRA ACLR2
100+25	5	3.79	Spur	2.22	EUTRA ACLR
	10	4.09	Spur	2.15	EUTRA ACLR
	20	3.98	Spur	1.84	Gap EUTRA ACLR
	40	4.04	Spur	1.49	UTRA ACLR2
25+50	5	4.70	Spur	2.76	UTRA ACLR2
	10	4.69	Spur	2.08	UTRA ACLR2
	20	4.84	Spur	1.58	UTRA ACLR1
	40	4.84	Spur	1.58	UTRA ACLR1
25+25	5	5.00	Spur	3.29	UTRA ACLR2
	10	5.57	Spur	0.63	UTRA ACLR1
	20	5.57	Spur	0.62	UTRA ACLR1
	40	5.58	Spur	0.62	UTRA ACLR1

6.2.2.4 Transmit intermodulation

Firstly, considering the transmit intermodulation product strongly affected by the level of whole wanted signal power, it is unreasonable to define intermodulation product for NC-CA by only using one sub block power as a wanted power when all sub blocks are transmit, so a proposal is given here (refer to the definition of ACLR for NC-CA).

- **Proposal 1: The UE transmit intermodulation attenuation is defined as a ratio of**
    - **The sum of the filtered mean powers centered on the assigned channel frequencies and**
    - **The filtered mean power centered on a frequency of intermodulation product of the sub block being tested.**

In order to ensure good co-existence with legacy systems, following UE transmit intermodulation requirements for non-contiguous intra-band CA are proposed.

- **Proposal 2: Interference CW signal level is set to -40dBc which is relative to the sum of the filtered mean powers centered on the assigned channel frequencies. The intermodulation product level for the 1st intermodulation test is -29dBc and the intermodulation product level for the 2nd intermodulation test is -35dBc.**

Note: 1st intermodulation test refers to case when CW signal frequency offset is equal to channel bandwidth being tested and the 2nd intermodulation test refers to case when CW signal frequency offset is equal to twice the channel bandwidth being tested.

As mentioned in R4-123807 and R4-125608, it was already proposed that the interference CW signal should not be allocated inside the gap when testing transmit intermodulation for NC –CA.

- **Proposal 3: Non-contiguous intraband CA Tx intermodulation requirement applies when the interfering signal is located at a positive offset with respect to the assigned channel frequency of the highest carrier frequency or located at a negative offset with respect to the assigned channel frequency of the lowest carrier frequency.**

However, when interference CW signal is allocated outside the RF bandwidth edges, one of the intermodulation products will also be effected by the sub block other than the sub-block being tested if the gap width is not large enough. One example is mentioned in R4-125608. In order to avoid the effect from other sub block, following additional definitions are proposed for UE NC-CA transmit intermodulation to accommodate varying gap size in requirement setting. (See Figure 6.2.2.4.1 to 6.2.2.4-3)

- **Proposal 4:**
  - **In case the sub block gap bandwidth Wgap < $BW_{CC\ being\ tested}$ then no intermodulation test inside the gap is performed**
  - **In case the sub block gap bandwidth $BW_{CC\ being\ tested} \leq$ Wgap <2 * $BW_{CC\ being\ tested}$ + $BW_{CC\ not\ tested}$ then 1st intermodulation test inside the gap is performed.**
  - **In case the sub block gap bandwidth Wgap≥2 * $BW_{CC\ being\ tested}$ + $BW_{CC\ not\ tested}$ then 1st and 2nd intermodulation tests inside the gap are performed.**

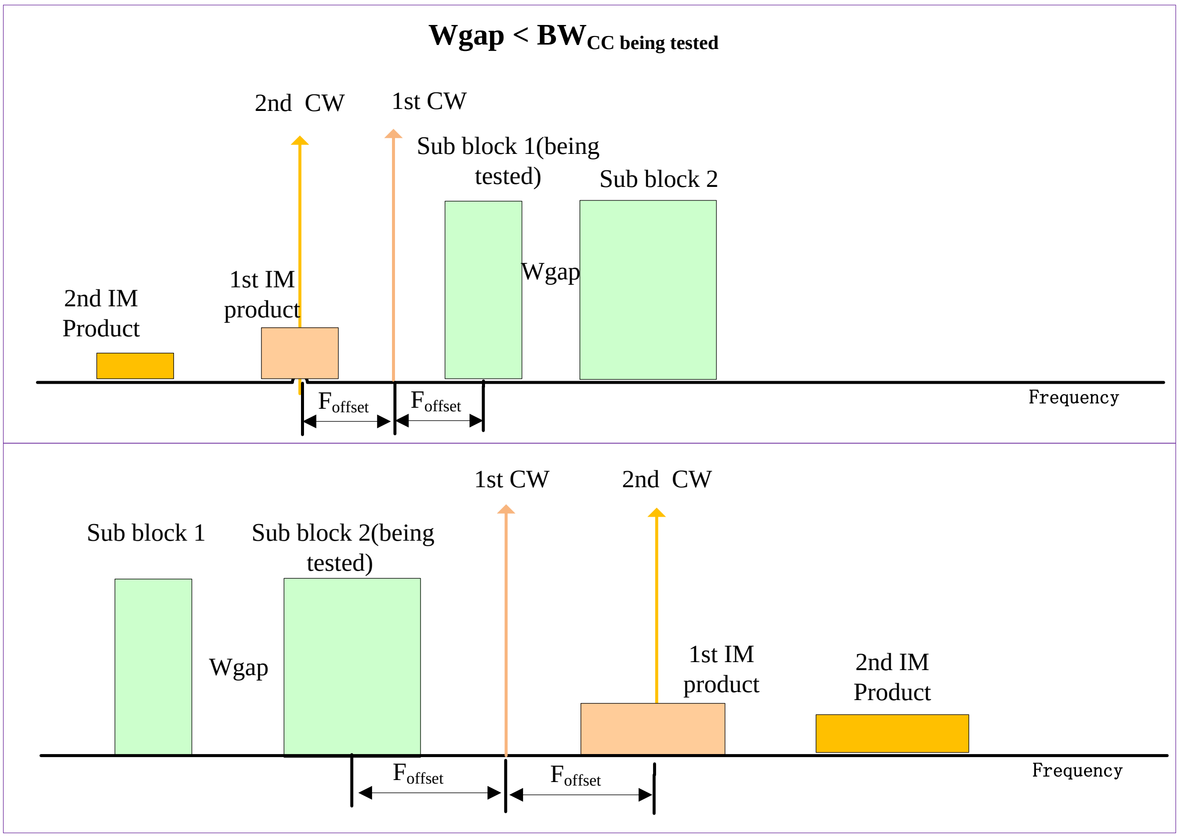


Figure 6.2.2.4-1: No intermodulation test inside the gap

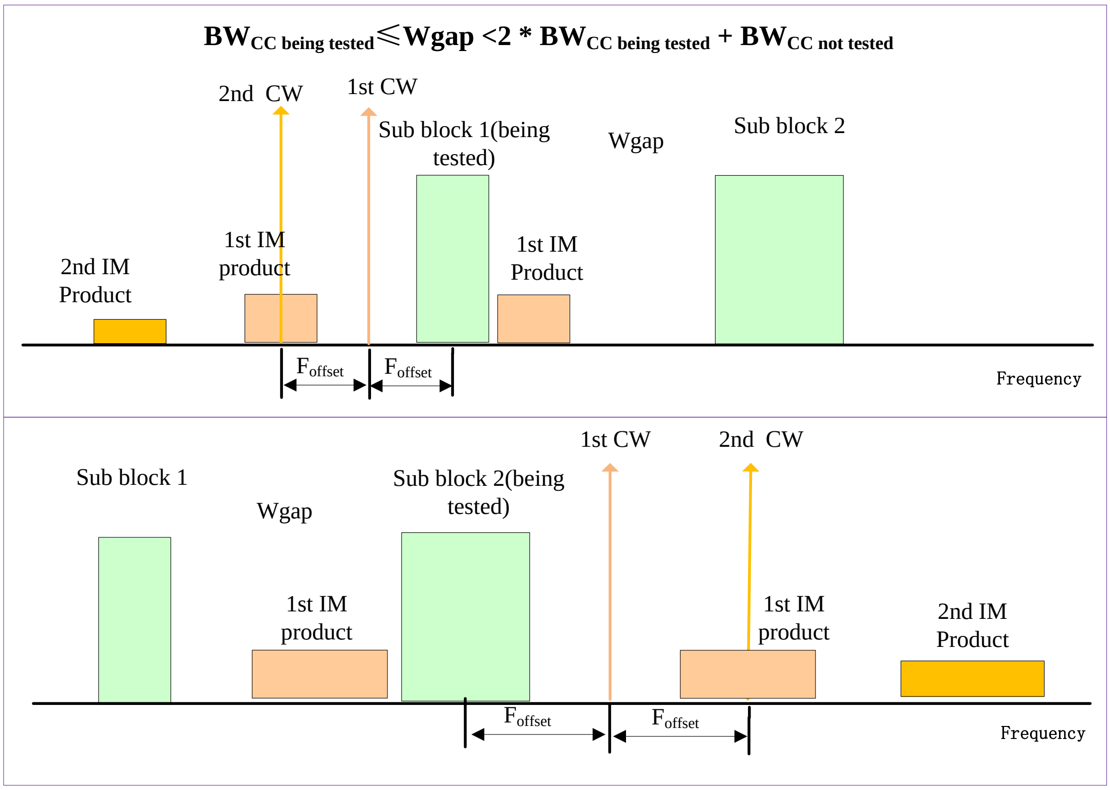


Figure 6.2.2.4-2: 1st intermodulation test

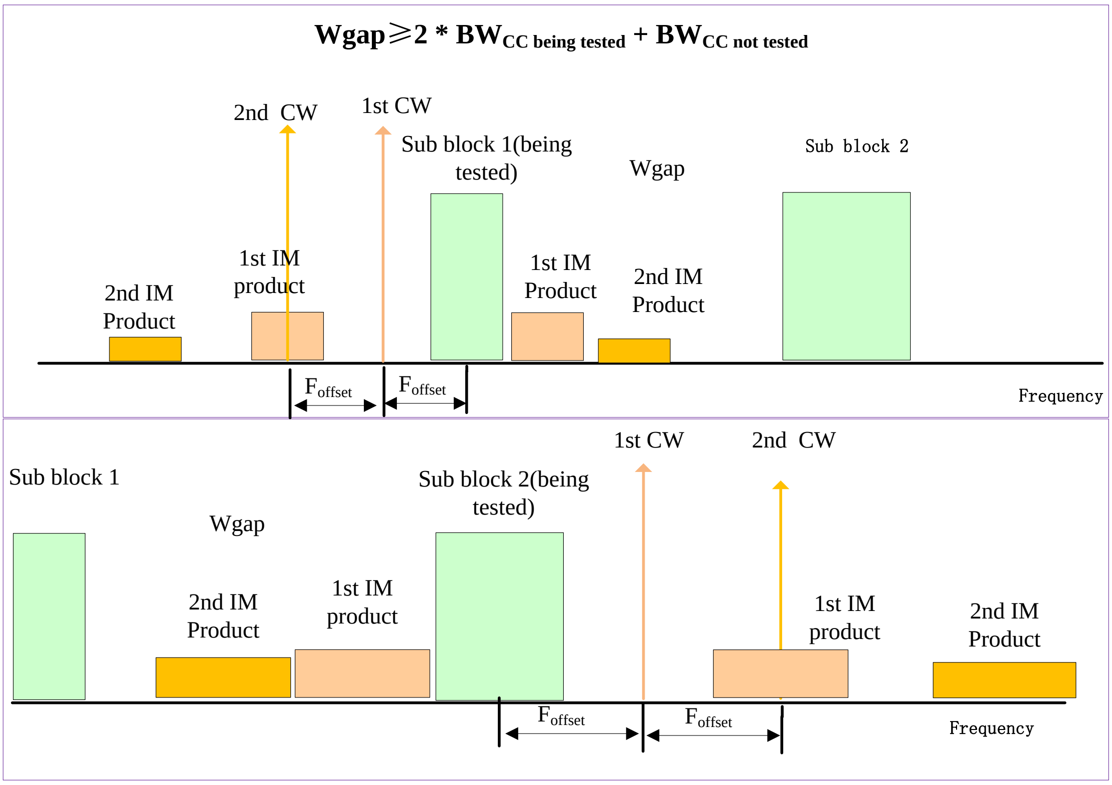


Figure 6.2.2.4-3: 2nd intermodulation test

6.2.3 Receiver characteristics

6.2.3.1 Reference Receiver Architecture

In NC-intraband operation UE must be able to receive two separate carriers located arbitrarily within a frequency band. If same deployment scenario assumptions apply as for single carrier operation it means that the power difference between adjacent carriers can be up to 33 dB as specified in 36.101. In order to have comparable performance to single carrier operation two separate receiver chains are assumed, see Figure 6.2.3.1-1.

Further studies are needed on what impact the division of the signal chain has on receiver noise figure.

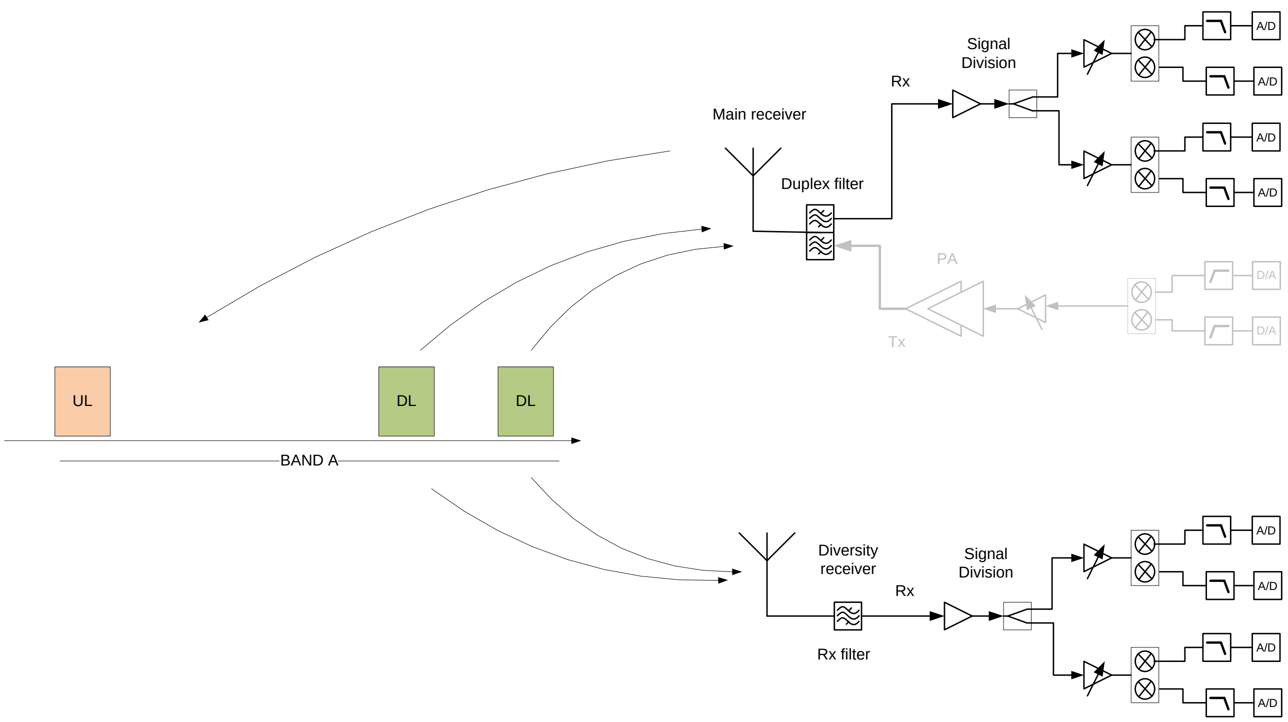


Figure 6.2.3.1-1: Reference receiver architecture

6.2.3.2 Reference sensitivity power level

The proposal is to reuse the Rel-8 REFSENS requirements as much as possible. First, we take the REFSENS values specified in Rel-8 (Table 7.3.1-1 in TS 36.101) without any change. Second, we follow the same approach as we take for the UL configurations, i.e., define the REFSENS requirements based on the operating band and channel bandwidth.

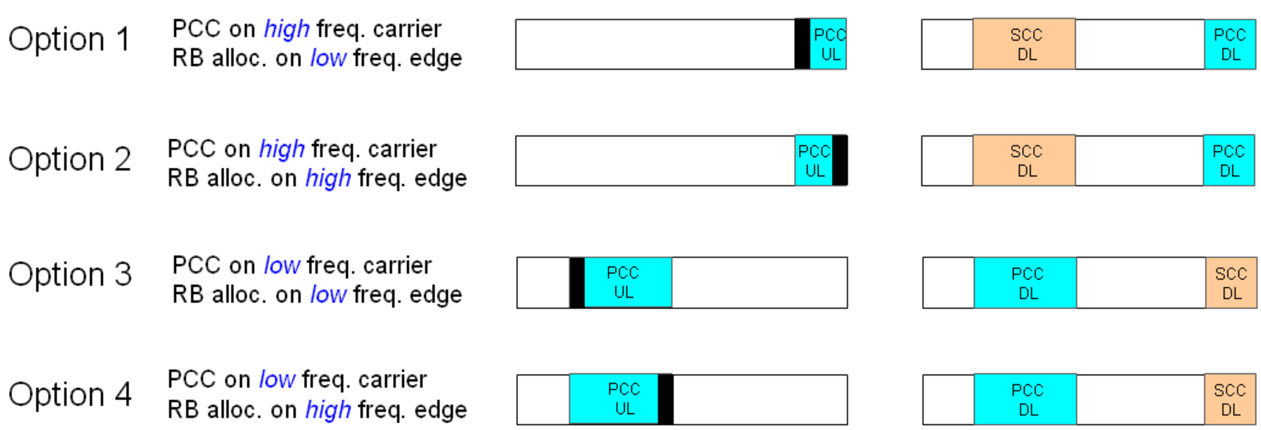


Figure 6.2.3.2-1: UL configurations.

One difference is that the REFSENS requirements are also defined based on the sub-block gap. More specifically, the impact of transmitter leakage is considered by defining the UL configurations for NC intra-band CA. Degradation of REFSENS from additional factors -- receiver IM2 noise, LO phase noise from both the transmitter and receiver, and additional Tx noise terms, where the transmitter is referring to the PCC UL transmitter and the receiver is referring to the SCC DL receiver -- are treated in further discussion below.

As shown in Figure 6.2.3.2-1 (Option 2), the carrier center frequency of PCC in the UL operating band is configured closer to the DL operating band. As the default configuration, the UL resource blocks are located as close as possible to the downlink operating band but confined within the transmission bandwidth configuration for the channel bandwidth. If no UL resource block is allowed without desensitization, the UL resource allocation is shifted toward the far-off end of the UL operating band, as specified for Band 2.

- **Proposal 1: The UL configurations are defined as a function of sub-block gap so as to avoid the desensitization due to transmitter leakage.**
  - **Proposal 1-1: As the default configuration, the UL resource blocks are located as close as possible to the downlink operating band but confined within the transmission bandwidth configuration for the channel bandwidth.**
  - **Proposal 1-2: If no UL resource block is allowed without desensitization, the UL resource allocation is shifted toward the far-off end of the UL operating band.**

The amount of transmitter leakage on the DL carrier closer to the UL operating band (DL SCC) is evaluated for Band 25 as a function of sub-block gap in Figure 6.2.3.2-2 through Figure 6.2.3.2-5 with respect to bandwidth combination. The transmitter leakage is measured at the output of duplexer (on the receiver side). The simulation parameters are set as follows:

- PA operating point: UTRA_ACLR1 satisfied at full output power for all allocations and all bandwidths using QPSK.
- Counter IM3: 60 dB
- IQ image: 25 dB
- Carrier leakage: 25 dB
- Duplexer attenuation: 50 dB
- Insertion loss: 3 dB
- Noise floor: -140 dBm/Hz at the PA output

The UL configurations set the maximum allowable number of UL resource blocks so as to avoid desensitization due to transmitter leakage. More specifically, the maximum allowable number of UL resource blocks should be set such that the transmitter leakage is kept below -109 dBm and -106 dBm for 5 MHz DL carrier (25RB + 25RB, 50RB + 25RB) and 10 MHz DL carrier (25RB + 50RB, 50RB + 50RB), respectively. If no UL resource block is allowed without desensitization, the UL resource allocation is shifted toward the far-off end of the UL operating band. For example, in Figure 6.2.3.2-2, if the sub-block gap is smaller than 30 MHz, the maximum allowable number of UL resource blocks is set to 25 and the transmitter leakage is kept below -109 dBm. If the sub-block gap is larger than 30 MHz and smaller than 45 MHz, the maximum allowable number of UL resource blocks is set to 15. If the sub-block gap is larger than 45 MHz and smaller than 55 MHz, the maximum allowable number of UL resource blocks is set to 5 with $RB_{start} = 10$. Note that the sub-block gap is upper-bounded by 55 MHz, since the duplexer gap is 15 MHz for Band 25.

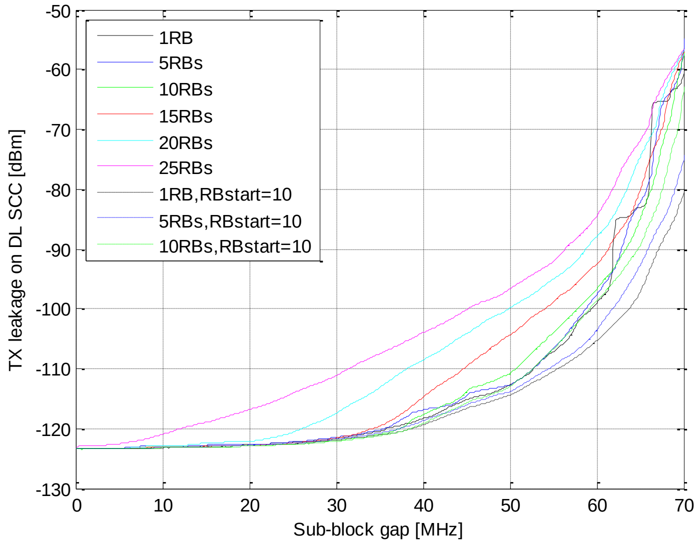


Figure 6.2.3.2-2: TX leakage amount: 25RB + 25RB.

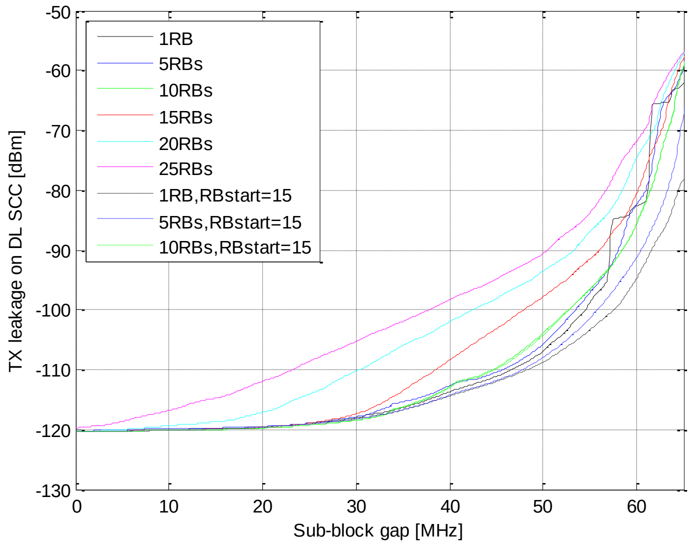


Figure 6.2.3.2-3: TX leakage amount: 25RB + 50RB.

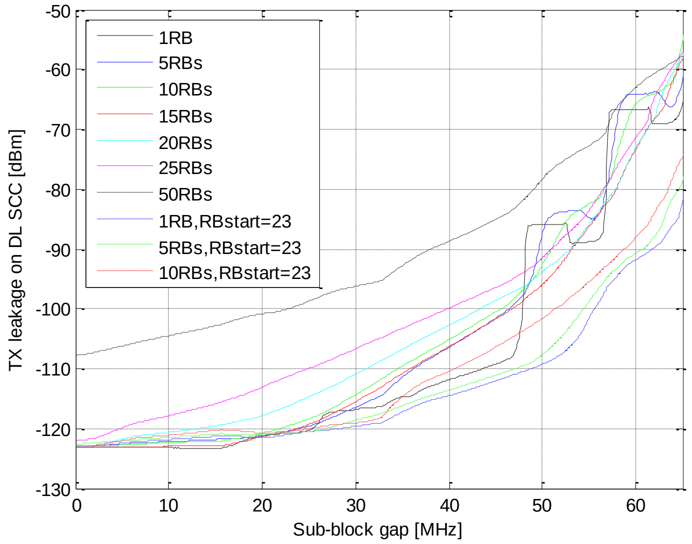


Figure 6.2.3.2-4: TX leakage amount: 50RB + 25RB.

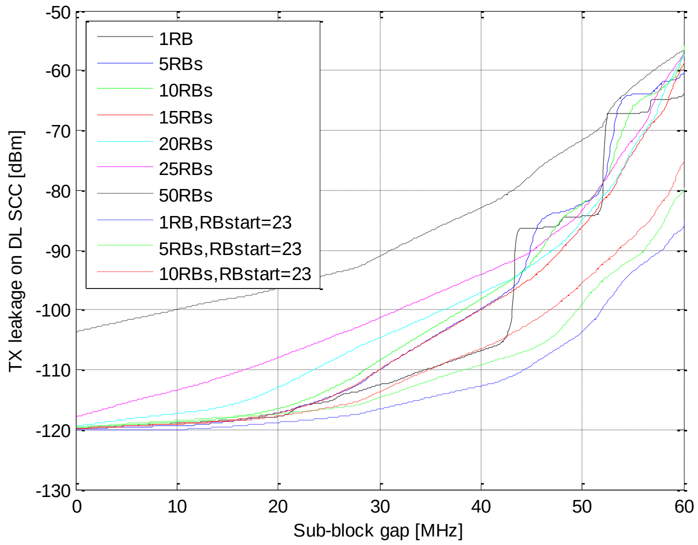


Figure 6.2.3.2-5: TX leakage amount: 50RB + 50RB.

Additional impairments beyond PA spectral regrowth have been identified to degrade reference sensitivity in the case of large sub-block gap. These include receiver IM2 noise, transmitter and receiver LO phase noise, and other transmitter noise sources.

Figures 6.2.3.2-6 and 6.2.3.2-7 illustrate the phase noise problem in non-contiguous intra-band CA. Due to the gap between the aggregated CCs, the gap between UL PCC and DL SCC can shrink down to the duplexer gap of the UL and DL bands. This increases self-desensitization not only due to intermodulation distortion but also due to phase noise. TX phase noise leaks into the RX (Figure 6.2.3.2-6), and TX power leaking into the RX will cause desensitization due to phase noise of the RX LO (Figure 6.2.3.2-7).

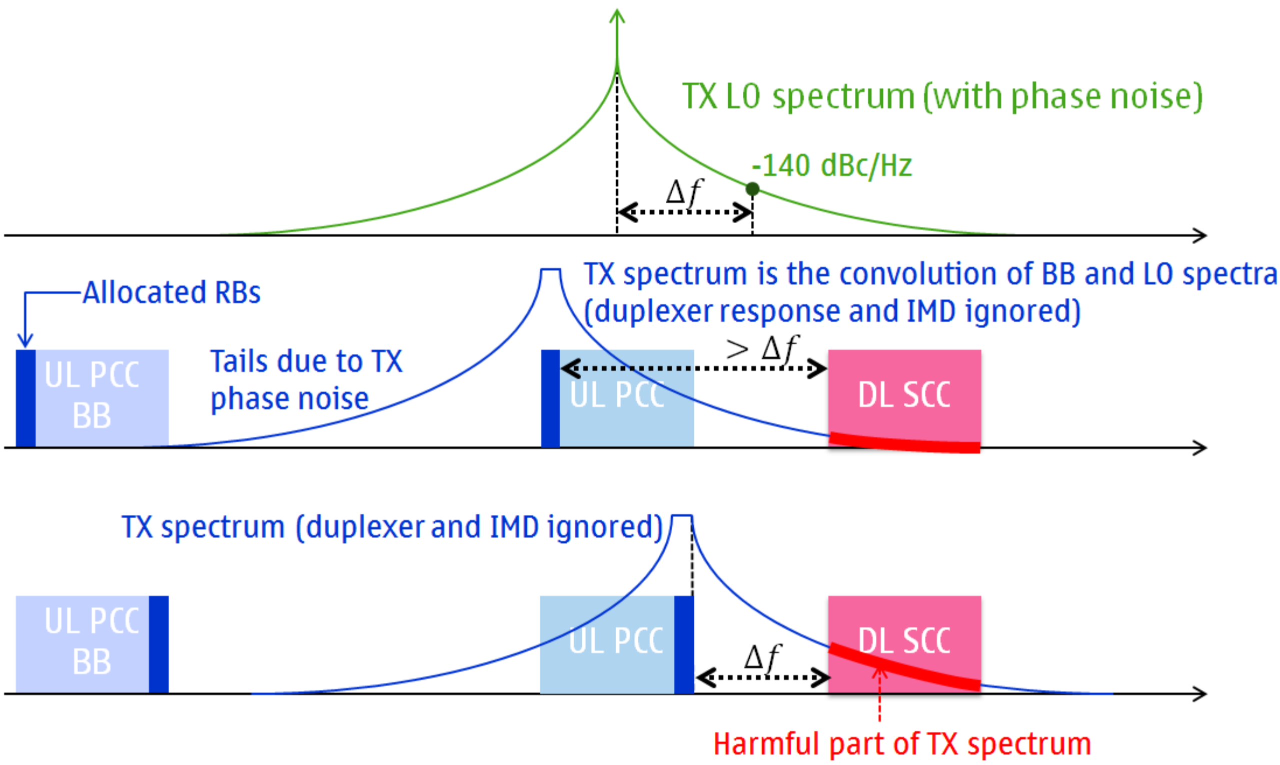


Figure 6.2.3.2-6: TX phase noise on RX band

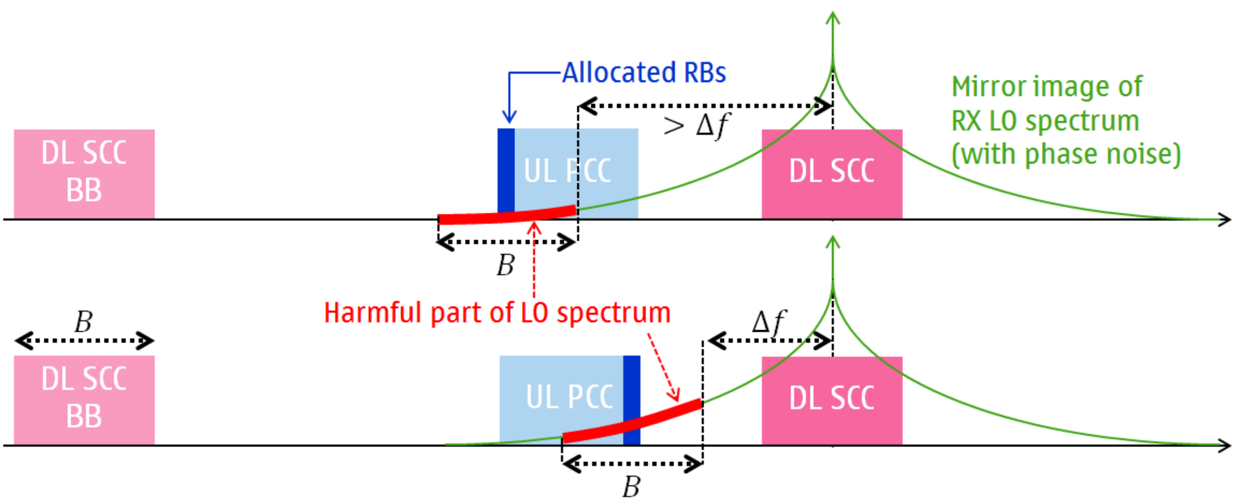


Figure 6.2.3.2-7: RX phase noise due to TX leakage

Taking these factors into account, the reference sensitivity specifications for non-contiguous intra-band CA with 1UL are defined as a function of the sub-block gap size. The PCC uplink allocation size may be reduced to minimize the impact of transmitter spectral regrowth on the SCC DL across the Tx-Rx separation between the PCC UL and SCC DL. Furthermore, the location of the uplink allocation may be adjusted to avoid most Tx baseband harmonic and intermodulation terms from reaching the SCC DL. Lastly, a relaxation to the reference sensitivity is specified to account for the additional factors such as LO phase noise and other transmitter noise terms that cannot be addressed by reducing the size or adjusting the location of the PCC uplink allocation.

6.2.3.3 Maximum input level

One of the most limiting factors for maximum input level is the dynamic range of LNA. In intra-band non-contiguous carrier aggregation, though the UEs have two separate receiver chains (LOs) to narrow down the actual component carrier channel bandwidth, but the front end LNA is still directly exposed to the duplexer according to the approved reference receiver architecture in [1]. Hence, the receiver performance such as the dynamic range of LNA would be impacted by the total power received over the operating band for intra-band non-contiguous CA UEs. So the following proposal 1 is given to define maximum input level for intra-band non-contiguous CA.

- **Proposal 1: For intra-band non-contiguous carrier aggregation, the maximum input level is defined as a sum of mean power received at the UE antenna port over each component carrier, at which the specified relative throughput shall meet or exceed the minimum requirements for the specified reference measurement channel over each component carrier.**

In order to keep each CC of the receiver having same performance with R8/9, the maximum input level should remain -25dBm, so the maximum input level of the UE should be up to -22dBm for intra-band non-contiguous CA.

- **Proposal 2: The maximum input level of the UE should be up to -22dBm for intra-band non-contiguous CA.**

In order to cover the case where both carriers are received at -25dBm, we assume equal power level for both carriers.

- **Proposal 3: Two non-contiguous carriers are set to have equal power during the test.**

6.2.3.4 Adjacent Channel Selectivity (ACS)

There are two different test scenarios: simultaneous test and separate test. In simultaneous test, two non-contiguous downlink carriers are tested simultaneously with respect to one interfering signal, whereas, in separate test, one downlink carrier is tested at one time with respect to one interfering signal.

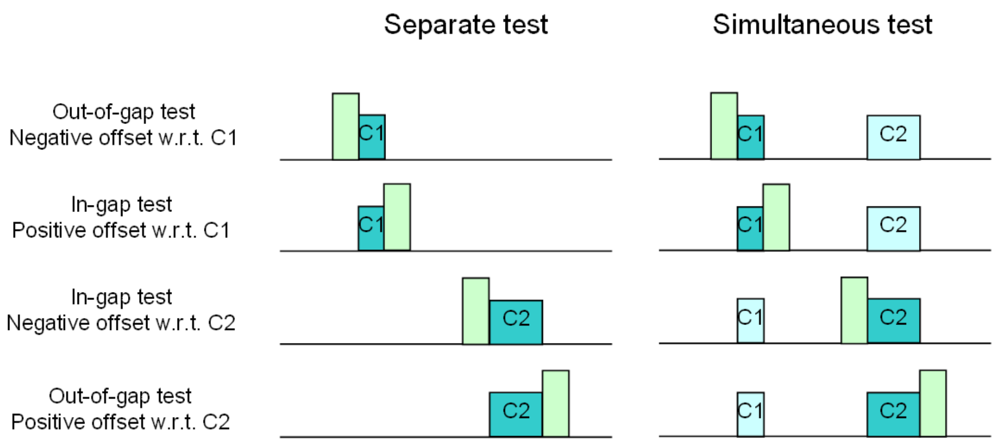


Figure 6.2.3.4-1: Test scenarios for ACS requirements.

Each test scenario consists of in-gap test and out-of-gap test. An interfering signal is located at either a positive offset or a negative offset with respect to each carrier. Therefore, for carrier aggregation with two carriers, each test scenario consists of four tests, as illustrated in Figure 6.2.3.4-1: in-gap tests with positive and negative offsets and out-of-gap tests with positive and negative offsets. Note that, in simultaneous test, both downlink carriers, C1 and C2, are present and tested simultaneously, whereas, in separate test, either C1 or C2 is present and tested at one time.

Since the typical operation condition of UE capable of intra-band non-contiguous carrier aggregation is better captured by the simultaneous test, we propose to use the simultaneous test for ACS requirements, as RAN4 agreed for NC-4C-HSDPA. For each of the four tests, both downlink carriers should satisfy the Rel-8 ACS requirements.

- **Proposal 1: Both non-contiguous carriers are tested simultaneously with respect to one interfering signal. Each carrier should satisfy the Rel-8 ACS requirements.**

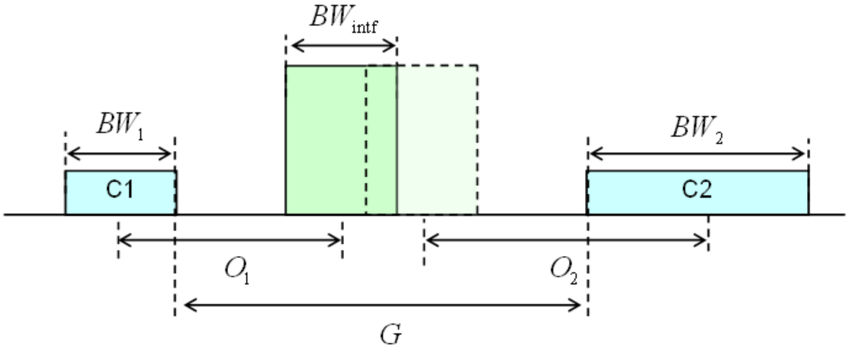


Figure 6.2.3.4-2: Condition for in-gap test.

For intra-band non-contiguous carrier aggregation, one interfering signal located inside the gap with respect to one carrier may be located closer to the other carrier than specified in Rel-8, unless the gap width is sufficiently large. Let us denote the channel bandwidth by BW_1 and BW_2 and the Rel-8 interference frequency offsets of an interfering signal by O_1 and O_2, as illustrated in Figure 6.2.3.4-2. In order to guarantee a minimum of the Rel-8 interference frequency offset from both carriers, the gap width G should satisfy the following condition:

$$G \geq O_1 + O_2 - 0.5\left(BW_1 + BW_2\right) \quad \text{[MHz]}. \qquad (1)$$

For the ACS requirements, the Rel-8 interference frequency offsets are given as

$$O_1 = 0.5\left(BW_1 + 5\right) \quad \text{[MHz]},$$

$$O_2 = 0.5\left(BW_2 + 5\right) \quad \text{[MHz]}. \qquad (2)$$

(Note that we confine ourselves to channel bandwidth of 5 MHz or above and thus the interference bandwidth BW_{intf} is always set to 5 MHz.) Therefore, by plugging (2) to (1), the condition for in-gap test is given as

$$G \geq 5 \quad \text{[MHz]}. \qquad (3)$$

Note that otherwise, the interference frequency offset is smaller than the value specified in Rel-8, in other words, the interfering signal overlaps with one of the carriers.

To sum up, we propose to define the in-gap ACS requirements only if the gap width is *sufficiently large*, as RAN4 agreed for NC-4C-HSDPA.

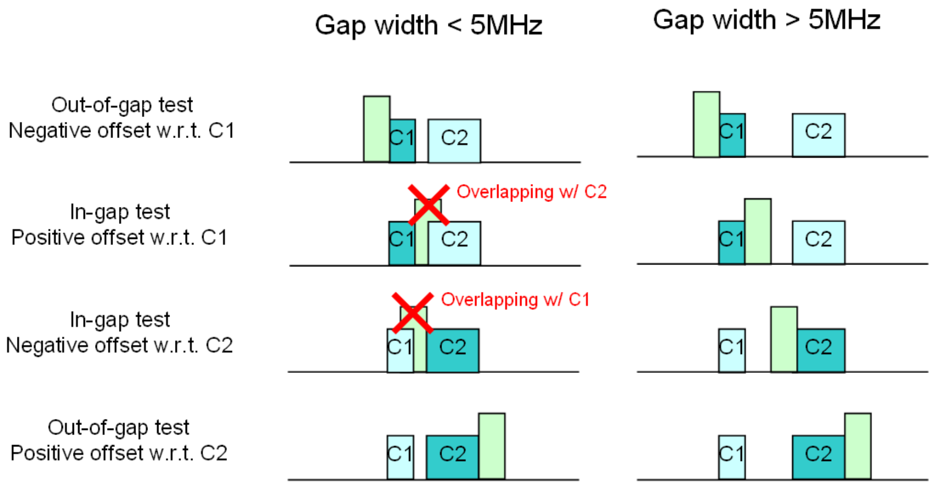


Figure 6.2.3.4-3: Simultaneous test with small gap width (C1: 5 MHz, C2: 10 MHz).

- **Proposal 2: The in-gap ACS requirements are defined only if the gap width is large enough to guarantee a minimum of the Rel-8 interference frequency offset from both carriers.**

This proposal is illustrated in Figure 6.2.3.3-3. If the gap width is smaller than 5 MHz, we define only two tests, i.e., the out-of-gap tests with positive and negative offsets.

According to the Rel-8 ACS requirements (Case 1), the power levels of wanted carriers and interfering signal are set based on the channel bandwidths of the wanted carriers. For example, in Band 25, in the case of 5 MHz, the power level is set to -82.5 dBm (REFSENS + 14 dB) and -51 dBm (REFSENS + 45.5 dB) for the carrier and the interfering signal, respectively. The selectivity level is set to -51 – (-82.5) = 31.5 dB. Figure 6.2.3.3-4 illustrates the Rel-8 ACS requirements (Case 1) for Band 25.

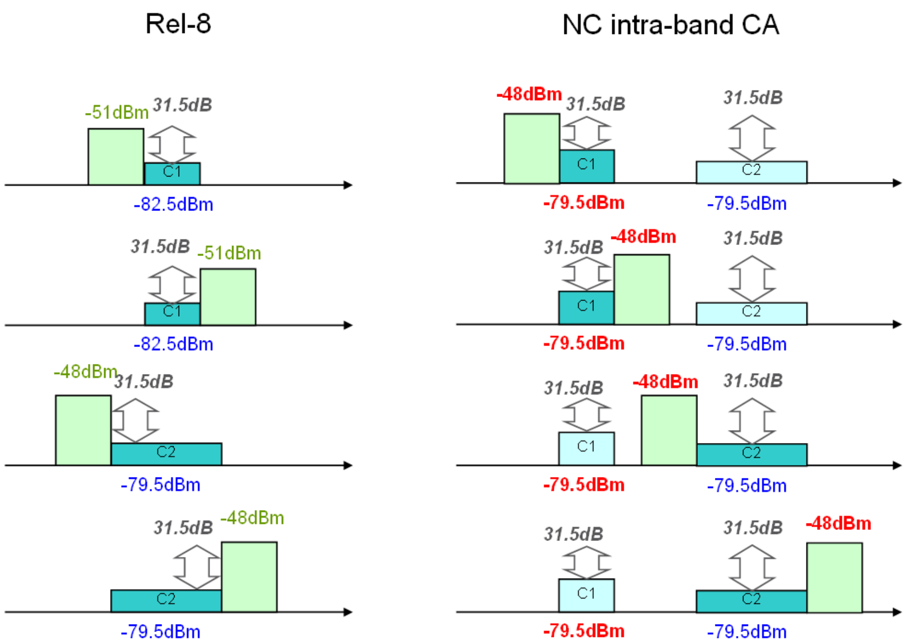


Figure 6.2.3.4-4: ACS requirements (C1: 5 MHz, C2: 10 MHz).

Therefore, in the case of two non-contiguous carriers with unequal channel bandwidth, the question is which carrier we refer to determine the power level of interfering signal. For example, in the case of one 10 MHz carrier and one 5 MHz carrier, if an interfering signal is located with respect to the 10 MHz carrier, the power level is set to -79.5 dBm (as depicted in Figure 6.2.3.4-4). On the other hand, if an interfering signal is located with respect to the 5 MHz carrier, the power level is set to -82.5 dBm.

Here we propose a principle of how to set the power level of interfering signal. The objective is to maintain the Rel-8 selectivity level on both carriers. We propose to choose the larger power levels between those specified by the Rel-8 ACS requirements in order to capture the selectivity capability better. Therefore, the carrier that the interfering signal is located with respect to keeps the Rel-8 selectivity level. However, the other carrier may see larger interferer power than in Rel-8. In order to keep the Rel-8 selectivity level for both carriers, the power level of the carrier other than the carrier that the interfering signal is located with respect to is increased by the difference between the interferer power levels specified in Rel-8.

- **Proposal 3: The interferer power level should be set to the larger power level between those specified by the Rel-8 ACS requirements The power level of the carrier other than the carrier that the interfering signal is located with respect to is increased so as to keep the Rel-8 selectivity level.**

Figure 6.2.3.4-4 shows the examples of how to apply this proposal. In Rel-8, the power level of interfering signal is set to -48 dBm for the 10 MHz carrier and -51 dBm for the 5 MHz carrier. According to this proposal, the power level of interfering signal is set to -48 dBm (the larger value between -48 dBm and -51dBm) with respect to the 10 MHz carrier. In order to maintain the same selectivity level (-31.5 dB), the power of the 5 MHz carrier is set to -48 – 31.5 = -79.5 dBm. In other words, the power of the 5 MHz carrier is increased by the difference between the two Rel-8 interference power levels, -48 – (-51) = 3 dB.

6.2.3.5 Blocking characteristic

There are two different test scenarios: simultaneous test and separate test. In simultaneous test, two non-contiguous downlink carriers are tested simultaneously with respect to one interfering signal, whereas, in separate test, one downlink carrier is tested at one time with respect to one interfering signal.

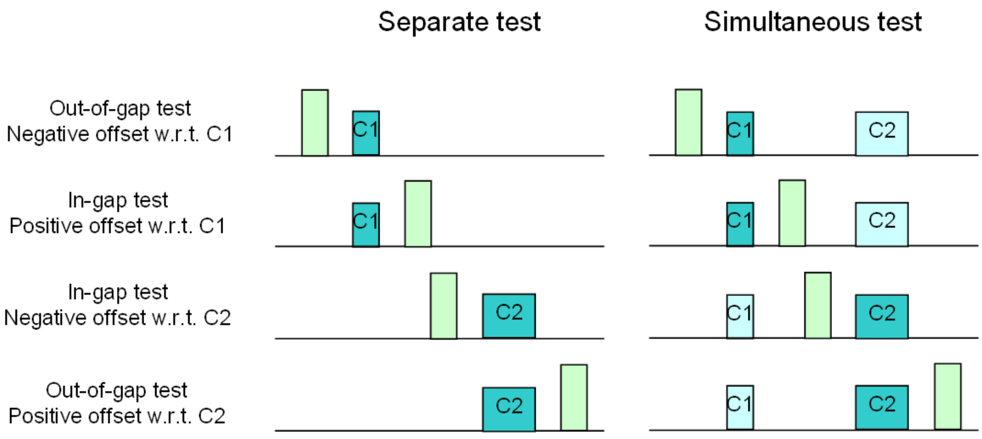


Figure 6.2.3.5-1: Test scenarios for IBB requirements.

Each test scenario consists of in-gap test and out-of-gap test. An interfering signal is located at either a positive offset or a negative offset with respect to each carrier. Therefore, for carrier aggregation with two carriers, each test scenario consists of four tests, as illustrated in Figure 6.2.3.5-1: in-gap tests with positive and negative offsets and out-of-gap tests with positive and negative offsets. Note that, in simultaneous test, both downlink carriers, C1 and C2, are present and tested simultaneously, whereas, in separate test, either C1 or C2 is present and tested at one time.

Since the typical operation condition of UE capable of intra-band non-contiguous carrier aggregation is better captured by the simultaneous test, we propose to use the simultaneous test for in-band blocking (IBB) requirements and narrow-band blocking (NBB), as RAN4 agreed for NC-4C-HSDPA. For each of the four tests, both downlink carriers should satisfy the Rel-8 IBB and NBB requirements.

- **Proposal 1: Both non-contiguous carriers are tested simultaneously with respect to one interfering signal. Each carrier should satisfy the Rel-8 IBB and NBB requirements.**

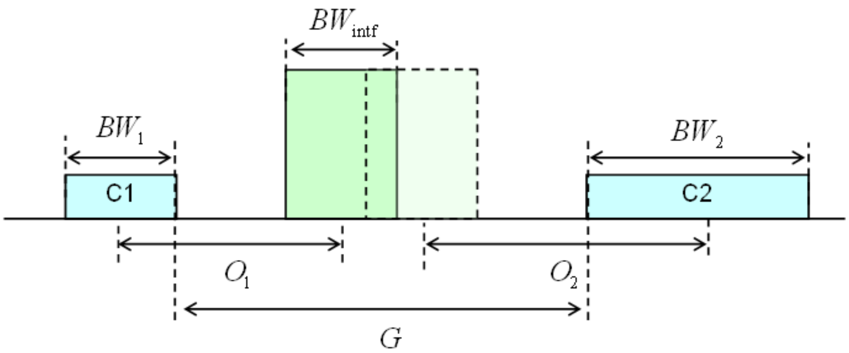


Figure 6.2.3.5-2: Condition for in-gap test.

For intra-band non-contiguous carrier aggregation, one interfering signal located inside the gap with respect to one carrier may be located closer to the other carrier than specified in Rel-8, unless the gap width is sufficiently large. Let us denote the channel bandwidth by BW_1 and BW_2 and the Rel-8 interference frequency offsets of an interfering signal by O_1 and O_2, as illustrated in Figure 6.2.3.5-2. In order to guarantee a minimum of the Rel-8 interference frequency offset from both carriers, the gap width G should satisfy the following condition:

$$G \geq O_1 + O_2 - 0.5\left(BW_1 + BW_2\right) \quad [\text{MHz}]. \qquad (1)$$

For the IBB Case 1 requirements, the Rel-8 interference frequency offsets are given as

$$O_1 = 0.5\left(BW_1 + 15\right) \quad [\text{MHz}],$$

$$O_2 = 0.5\left(BW_2 + 15\right) \quad [\text{MHz}]. \qquad (2)$$

For the IBB Case 2 requirements, the Rel-8 interference frequency offsets are given as

$$O_1 = 0.5\left(BW_1 + 25\right) \quad [\text{MHz}],$$

$$O_2 = 0.5\left(BW_2 + 25\right) \quad [\text{MHz}]. \qquad (3)$$

(Note that we confine ourselves to channel bandwidth of 5 MHz or above and thus the interference bandwidth BW_{intf} is always set to 5 MHz.) Therefore, by plugging (2) to (1), the condition for in-gap test is given as

$$G \geq 15 \quad [\text{MHz}] \qquad (4)$$

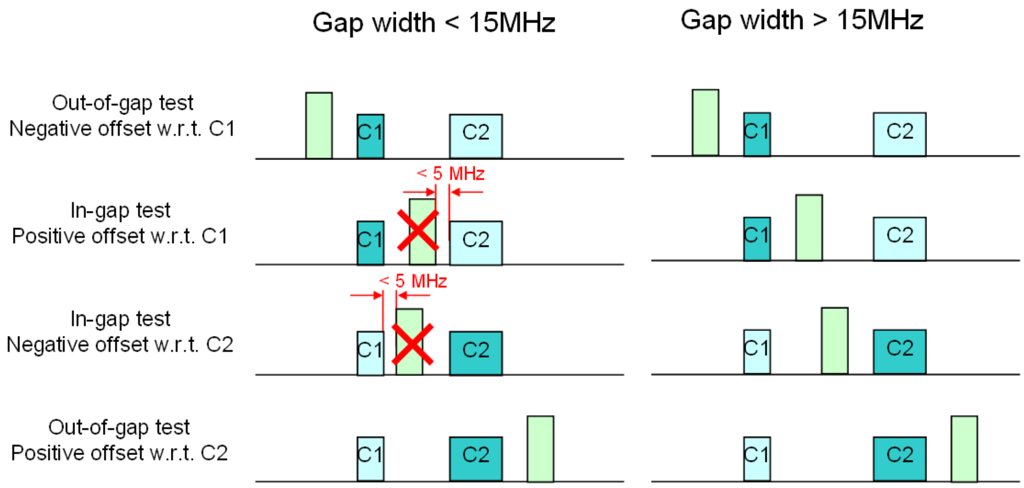


Figure 6.2.3.5-3: Simultaneous test (IBB Case 1) with small gap width (C1: 5 MHz, C2: 10 MHz).

for the IBB Case 1 requirements and

$$G \geq 25 \quad [\text{MHz}] \qquad (5)$$

for the IBB Case 2 requirements. Note that otherwise, the interference frequency offset is smaller than the value specified in Rel-8, in other words, the interfering signal is located closer to one of the carriers than in Rel-8.

To sum up, we propose to define the in-gap IBB and NBB requirements only if the gap width is *sufficiently large*, as RAN4 agreed for NC-4C-HSDPA.

- **Proposal 2: The in-gap IBB and NBB requirements are defined only if the gap width is large enough to guarantee a minimum of the Rel-8 interference frequency offset from both carriers.**

This proposal is illustrated in Figure 6.2.3.5-3 in the case of IBB Case 1. If the gap width is smaller than 5 MHz, we define only two tests, i.e., the out-of-gap tests with positive and negative offsets.

According to subclause 7.6.2 and 7.7 in TS36.101 Rel.8, it is known that both out-of-band blocking and the spurious response are tested for the unwanted CW interfering signal falling more than 15 MHz below or above the UE receive band, as shown in figure 1.so it is not necessary to introducing in-gap test for out-of-band blocking and the spurious response.

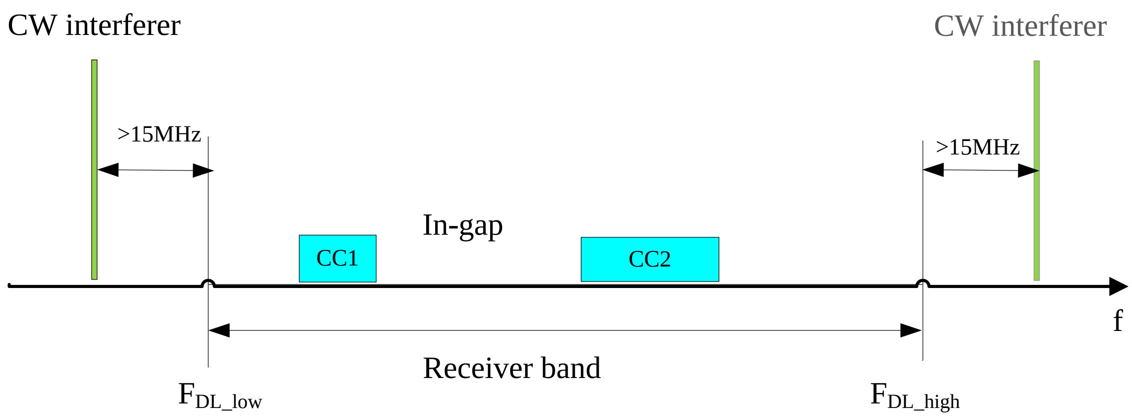


Figure 6.2.3.5-4: Condition for out-of band blocking and spurious response test

In order to keep the test scenarios consistent with other receiver characteristics such as ACS and in-band blocking for non-contiguous intra-band CA, the following proposal is given for spurious response for non-contiguous intra-band CA.

- **Proposal 1: Both non-contiguous carriers are active and being tested simultaneously with respect to one interfering signal. Each carrier should satisfy the Rel-8 out-of-band blocking and the spurious response requirements.**

For inter-band CA, it was agreed R4-126048 that the number of exceptions, i.e., the number of spurious response frequencies, is defined on a per-carrier basis. We believe that it is reasonable to follow this approach, since both inter-band CA and intra-band NC CA assume the use of two homodyne receivers in the reference architecture. We propose to apply the number of exceptions defined in Rel-8 to each carrier individually.

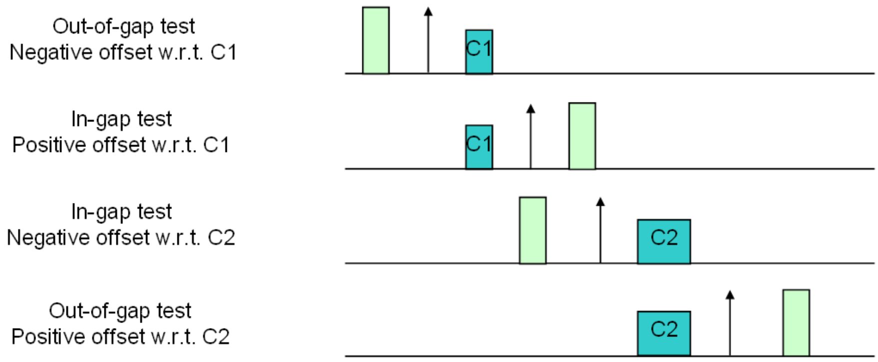
- **Proposal 2: Each carrier has the same number of exceptions as defined in Rel-8.**

6.2.3.6 Intermodulation characteristics

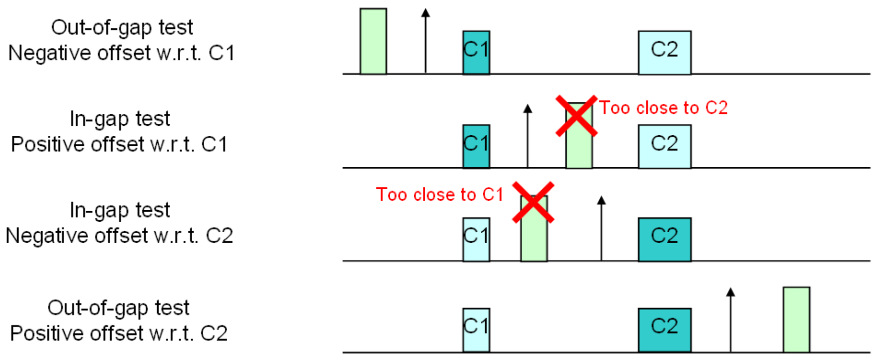
Intermodulation response rejection is a measure of the capability of the receiver to receive a wanted signal on its assigned channel frequency in the presence of two or more interfering signals which have a specific frequency relationship to the wanted signal. The wide band intermodulation requirement is defined following the same principles using modulated E-UTRA carrier and CW signal as interferer.

Similar to the ACS and blocking requirements, there are two different test scenarios for the wide band intermodulation requirements: simultaneous test and separate test. In simultaneous test, two non-contiguous downlink carriers are active and being tested simultaneously with respect to the two interfering signals (modulated E-UTRA carrier and CW signal), whereas, in separate test, one downlink carrier is tested at one time with respect to the interfering signals.

Each test scenario consists of in-gap test and out-of-gap test. The interfering signals are located at either a positive offset or a negative offset with respect to each carrier. Therefore, for intra-band NC CA with two carriers, each test scenario consists of four tests, as illustrated in Figure 6.2.3.6-1: in-gap tests with positive and negative offsets and out-of-gap tests with positive and negative offsets. Note that, in simultaneous test, both downlink carriers, C1 and C2, are present and tested simultaneously, whereas, in separate test, either C1 or C2 is present and tested at one time.



(a)



(b)

Figure 6.2.3.6-1: Test scenarios for wide band intermodulation requirements (a) separate test (b) simultaneous test.

Since a typical operation condition of UE capable of intra-band NC CA is better captured by the simultaneous test, we propose to use the simultaneous test for wide band intermodulation requirements. This is consistent with what RAN4 has agreed for the ACS requirements and in-band blocking requirements for intra-band NC CA. It should be noted that the simultaneous test was also agreed for LTE intra-band contiguous CA and NC-4C-HSDPA.

- **Proposal 1: Both non-contiguous carriers are active and being tested simultaneously with respect to a modulated E-UTRA signal and a CW signal as interference.**

In order to guarantee the same receiver linearity as for the single-carrier case, for each of the four tests, both downlink carriers should satisfy the Rel-8 wide band intermodulation requirements. In other words, the power of downlink carriers and interfering signals and also the frequency offset of interfering signals follow those for the Rel-8 wide band intermodulation requirements. This is consistent with what was agreed for NC-4C-HSDPA.

- **Proposal 2: Each carrier should satisfy the Rel-8 wide band intermodulation requirements.**

One issue of the simultaneous test is that the in-gap test may have the interfering signals too close to one of the carriers, more accurately, the carrier other than the carrier which the interfering signals are located with respect to. For example, when the in-gap test has the interfering signals at a positive offset with respect to C1 (as illustrated in Figure 6.2.3.6-1 (b)), the interfering signals (the modulated E-UTRA signal) may be located so close to C2 that the interfering signals degrade the performance of C2. Assuming channel bandwidth larger than or equal to 5 MHz, there is (almost) no impact on in-gap test, if the gap length satisfies the following condition:

$$(\text{Gap length}) \geq (\text{Interferer frequency offset 1}) + (\text{Interferer frequency offset 2})$$

$$-0.5*(\,(\text{Channel bandwidth 1}) + (\text{Channel bandwidth 2})\,) \qquad (1)$$

where the interferer frequency offset represents the frequency offset between the modulated E-UTRA interfering signal and the wanted carrier ($F_{interferer\ 2}$ (offset) specified in subclause 7.8.1.1). Note that the condition in (1) is equivalent to having a gap length that guarantees a minimum of the Rel-8 interference frequency offset from both the carriers, as considered in the in-band blocking requirements. As to how to define the wide band intermodulation requirements for in-gap test, we can consider the following two options:

- **Option 1**: The in-gap test should be considered only if the gap length satisfies the condition in (1).
- **Option 2**: The in-gap test should be skipped, regardless of the gap length.

If the in-gap test is skipped, the simultaneous test consists of two out of four tests, e.g., an out-of-gap test with negative offset with respect to C1 and an out-of-gap test positive offsets with respect to C2.

Recalling that it is the receiver linearity (not the selection or blocking capability) that is measured in the intermodulation test, it is possible to skip in-gap test and rely on out-of-gap test in intra-band NC CA. Therefore, we propose Option 2. In addition, Option 2 helps to save the testing time/effort since it skips two out of four tests. Moreover, Option 2 is simpler in that it is readily applicable to any channel bandwidth (whereas Option 1 may end up with channel bandwidth larger than or equal to 5 MHz, as in the ACS and in-band blocking requirements). Lastly, it is consistent with what was agreed for NC-4C-HSDPA.

- **Proposal 3: The in-gap test should be skipped, regardless of the gap length (Option 2).**

Annex A: Change history

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
2011-10	R4#60bis	R4-114868			Skeleton TR for Carrier Aggregation Enhancements		0.0.1
2012-02	R4#61	R4-116230			Scope of non-contiguous intraband CA		0.0.2
2012-02	R4#62	R4-120468			NC-intra-band CA reference receiver architecture		0.0.2
2012-05	R4#63	R4-122750			NC-intraband UE RF terminology		0.1.0
2012-05	R4#63	R4-122759			Addition of Annex A for draft specification		0.1.0
2012-05	R4#63	R4-122764			CA configuration acronyms for non-contiguous intraband CA		0.1.0
2012-05	R4#63	R4-123657			Multiple Timing Advances and Random Access of the SCell		0.1.0
2012-08	R4#64	R4-124353			Non-contiguous intraband unwanted emission		0.2.0
2012-08	R4#64	R4-124357			non-contiguous intra-band reference transmitter architecture		0.2.0
2012-08	R4#64	R4-124922			Non-contiguous intraband CA ACLR		0.2.0
2012-10	R4#64bis	R4-125528			Non-contiguous intraband CA Clause 5 changes		0.3.0
2012-10	R4#64bis	R4-125941			Non-contiguous intraband CA power control		0.3.0
2012-10	R4#64bis	R4-125942			Non-contiguous intraband CA unwanted emissions		0.3.0
2012-10	R4#64bis	R4-125943			Non-contiguous intraband CA ACLR		0.3.0
2012-10	R4#64bis	R4-125944			Non-contiguous intraband CA minimum and off power requirement		0.3.0
2012-10	R4#64bis	R4-125950			Non-contiguous intraband CA UE to UE co-existence		0.3.0
2012-11	R4#65	R4-126429			NC-intraband CA ON/OFF time mask		0.4.0
2012-11	R4#65	R4-126594			Frequency error for NC intra-band CA		0.4.0
2012-11	R4#65	R4-126963			ACS requirements for NC intra-band CA		0.4.0
2012-11	R4#65	R4-126964			REFSENS with one UL carrier for NC intra-band CA		0.4.0
2012-11	R4#65	R4-126965			In-band blocker requirements for NC intra-band CA		0.4.0
2012-11	R4#65	R4-126968			TP on transmit intermodulation for non-contiguous intra-band CA		0.4.0
2013-01	R4#66	R4-130975			Wide band intermodulation requirements for intra-band NC CA		0.5.0
2013-01	R4#66	R4-130879			Maximum input level for non-contiguous intra-band CA		0.5.0
2013-01	R4#66	R4-130873			Out-of-band blocking and spurious response for non-contiguous intra-band CA		0.5.0
2013-01	R4#66	R4-130057			Narrow band blocking requirements for NC intra-band CA		0.5.0
2013-01	R4#66	R4-130060			Spurious response requirements for intra-band NC CA		0.5.0
2013-01	R4#66	R4-130872			Definition of sub-block gap bandwidth for intra-band NC CA		0.5.0
2013-01	R4#66	R4-130957			TP on REFSENS with 1 UL for NC intra-band CA		0.5.0
2013-01	R4#66	R4-130617			TP on Pcmax for MTA case		0.6.0
2013-03	RP#59	RP-130218			Submission to RAN for approval		1.0.0
2013-03	RP#59				TR approved by RAN	1.0.0	11.0.0