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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 the present document is to summarize the study of radio requirements for the User Equipment (UE) radio transmission and reception as part of the Rel-10 work item on;

a) **C**arrier **A**ggregation for LTE (CA)

b) Enhanced **DL** **M**ultiple **A**ntenna Transmission for LTE (DLMA)

c) **UL** **M**ultiple **A**ntenna transmission for LTE (ULMA)

d) Fixed Wireless **CPE** RF Requirements (CPE)

2 References

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

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

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

[2] 3GPP TS 36.101 (10.3.0): "User Equipment (UE) radio transmission and reception".

[3] RP-091101: "Carrier Aggregation for LTE; WID, REL-10".

[4] RP-091429: "Enhanced Downlink Multiple Antenna Transmission for LTE; WID, REL-10".

[5] RP-091430: "UL multiple antenna transmission for LTE; WID, REL-10".

[6] RP-091224: "Fixed wireless CPE RF performance specification; WID, REL-10".

[7] 3GPP TS 36.942 V9.0.0 (2009-12): "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Frequency (RF) system scenarios".

[8] 3GPP TS 43.030 V9.0.0 (2009-12): "Radio network planning aspects".

[9] R4-092953: "New UE power class", Verizon.

[10] R4-102023: "ACLR model for CPE Coexistence studies in Band13 and Band14", LG Electronics.

[11] R4-103586: "UL Power control for CPE to E-UTRA BS coexistence study", Huawei.

[12] R4-104250: "MCL for CPE to E-UTRA BS coexistence studies", Alcatel-Lucent.

3 Symbols and abbreviations

3.1 Symbols

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

$BW_{Channel\_CA}$ Aggregated channel bandwidth, expressed in MHz.

BW_{GB}	Virtual guard band to facilitate transmitter (receiver) filtering above / below edge CCs.
F_{C_high}	The centre frequency of the *highest carrier*, expressed in MHz.
F_{C_low}	The centre frequency of the *lowest carrier*, expressed in MHz.
F_{edge_high}	The *higher edge* of aggregated channel bandwidth, expressed in MHz.
F_{edge_low}	The *lower edge* of aggregated channel bandwidth, expressed in MHz.
F_{offset}	Frequency offset from F_{C_high} to the *higher edge* or F_{C_low} to the *lower edge*.
N_{RB_agg}	Aggregated Transmission Bandwidth Configuration. The number of aggregated RBs transmitted/received within the Aggregated Channel Bandwidth simultaneously.

3.2 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].

CA	Carrier Aggregation
CA_X	Carrier Aggregation for band X where X is the applicable E-UTRA operating band
CA_X-Y	Carrier Aggregation for band X and Band Y where X and Y are the applicable E-UTRA operating band
CPE	Customer Premise Equipment
CPE_X	Customer Premise Equipment for E-UTRA operating band X
DLMA	Down link Multiple Antenna transmission
ULMA	Up link Multiple Antenna transmission

4 General

4.1 Relationship between minimum requirements and test requirements

4.2 Applicability of minimum requirements

4.3 Applicability of minimum requirements (CA, ULMA, DLMA, CPE)

a) In Annex B (Release 10 working assumptions) the requirements are specified as general requirements and additional requirements specific to CA, UL-MA, DL_MA and CPE which are specified as suffix A, B, C, D where:

- Suffix A additional requirements need to support CA
- Suffix B additional requirements need to support DLMA
- Suffix C additional requirements need to support ULMA
- Suffix D additional requirements need to support CPE

b) A terminal which support these features need to meet both the general requirements and the additional requirement applicable to the additional sub-clause. Where there is a difference in requirement between the general requirements and the additional sub-clause requirements the tighter requirements are applicable unless stated otherwise in the additional sub-clause

c) A terminal which support more than one additional requirements (CA, ULMA, DLMA and CPE) would need to both sets of requirements

4.4 Method for specification of inter-band CA

For inter-band carrier aggregation, the following method should be used for specifying minimum requirements for specific operating-band combinations:

1. Classes of inter-band combinations are created with specific technical characteristics
2. Methods for specifying combinations belonging to a certain class are developed
   - Once developed, newly proposed inter-band combinations within a class can be specified readily
3. Combinations will be introduced in a release independent manner into a relevant class within the methodology of the frame work

The classes of combinations are defined using frequency separation between operating bands as a coarse basis, and with subclasses based on technical challenge:

- Harmonic relation between bands combined;
- Intermodulation products.

For each inter-band combination, the constituent operating bands are designated a:

- "Low" band if the maximum of the upper frequency limit of the transmit and receive frequency band is < 1 GHz
- "High" band if the minimum of the lower frequency limit of the transmit and receive frequency band is > 1.7 GHz

The following tentative classes are defined:

A1. Low-high band combination without harmonic relation between bands

A2. Low-high band combination with harmonic relation between bands

A3. Low-low or high-high band combination without intermodulation problem (low order IM)

A4. Low-low or high-high band combination with intermodulation problem (low order IM)

Combinations with operating bands in the 1.5 GHz are designated into the above classes on a case-by-case basis.

5 Operating bands and channel arrangement

5.1 General

5.2 Void

5.3 Void

5.4 Void

5.5 Operating bands

5.5A CA Operating bands

CA operating bands will be based on the CA bands defined in Section 8 for CA intra band contiguous and non contiguous CA inter band.

As more and more deployment scenarios are agreed based on operators input derived from an operators list on Annex A those could be added on release independent manner.

Table 5.5A-1: Intra band CA operating bands

E-UTRA CA Band	E-UTRA Band	Uplink (UL) operating band BS receive / UE transmit FUL_low – FUL_high			Downlink (DL) operating band BS transmit / UE receive FDL_low – FDL_high			Duplex Mode
CA_1	1	1920 MHz	–	1980 MHz	2110 MHz	–	2170 MHz	FDD
CA_40	40	2300 MHz	–	2400 MHz	2300 MHz	–	2400 MHz	TDD

Table 5.5A-2: Inter band CA operating bands

E-UTRA CA Band	E-UTRA Band	Uplink (UL) operating band BS receive / UE transmit FUL_low – FUL_high			Downlink (DL) operating band BS transmit / UE receive FDL_low – FDL_high			Duplex Mode
CA_1-5	1	1920 MHz	–	1980 MHz	2110 MHz	–	2170 MHz	FDD
	5	824 MHz	–	849 MHz	869 MHz	–	894 MHz	
CA_3-7	3	1710 MHz	–	1785 MHz	1805 MHz	–	1880 MHz	FDD
	7	2500 MHz	–	2570 MHz	2620 MHz	–	2690 MHz	
CA_4-13	4	1710 MHz	–	1755 MHz	2110 MHz	–	2155 MHz	FDD
	13	777 MHz	–	787 MHz	746 MHz	–	756 MHz	
CA_4-17	4	1710 MHz	–	1755 MHz	2110 MHz	–	2155 MHz	FDD
	17	704 MHz	–	716 MHz	734 MHz	–	746 MHz	

5.6A CA Channel bandwidth

Principle for deriving an Aggregated Channel Bandwidth

Aggregated Channel Bandwidth can be defined as the bandwidth in which a UE transmits (receives) multiple CCs simultaneously. The following principle options exist to define this:

1. Assume available spectrum blocks of size n*5 MHz (or n*20 MHz) as the Aggregated Channel Bandwidth. Then derive suitable CA CC configurations including appropriate internal transition (guard) bands at the edge CCs as well as inter-CC carrier spacing.

2. Derive the Aggregated Channel Bandwidth from the configuration of the CCs by considering the nominal CC channel spacing and a guard bands above the highest (below the lowest) transmitted/received CC.

The following can be observed:

1. Available spectrum blocks might not always be of size n*5 MHz as was noted in RAN4 e.g. for the 3.5 GHz band.

2. Option 1.) tends to result in larger guard bands or addition of smaller CCs to fill these.

3. Option 1.) with n*20 MHz scales worse towards 60 … 100 MHz as it results in large guard bands (for closely spaced CCs).

4. Option 2) better reflects actual physics / emissions which are driven by the actual CC configuration, not license block sizes.

5. The resulting Aggregated Channel Bandwidth in Option 2) will not be a multiple of 5 MHz, but an "odd" number like 38.3 MHz for 100 + 100 RB CA. On the other hand this it indicates the minimum needed spectrum for a CC configuration (in form of 3GPP TX/RX requirements), and any additional frequencies within n*5 MHz blocks could be available to enhance co-existence to adjacent systems even further.

6. For the BS option 2.) is used in for multi-carrier and MSR specifications.

Regarding the above points, option 2.) shall be applicable for the definition of aggregated channel bandwidth.

Guard bands at the edge CCs

Shall GB be symmetrical or asymmetrical?

When considering a transmission where all component carriers are fully populated and transmitted at highest possible maximum output power (typical SEM test configuration) the spectral re-growth generated in PA is the dominant OOB region noise contributor. In this case the bandwidths of individual component carriers do not play significant role how the emissions are spread into OOB region instead the aggregated channel bandwidth is the parameter that defines this phenomenon. Thus it is logical to define guard bands to symmetrical at each side of aggregated channel bandwidth.

Furthermore symmetrical GB would significantly simplify the filtering design complexity because symmetrical GB enables the same transmitter/receiver requirements to be defined at both edges of the transmitted/received signals.

It has been agreed that the same GB shall be applied at each side of Aggregated Channel Bandwidth.

Shall GB values be fixed or relative to the Aggregated Channel Bandwidth?

Among others, the guard bands facilitate TX spectrum shaping filtering. In REL-9 the guard bands are relative to BW_channel (~10%). Scaling this upwards to e.g. 80 MHz will lead to large guard bands, hence the need for this should be investigated. Variable guard bands also complicate CA migration scenarios like extending 2*100 RB CA towards 3*100 RB CA as the edges of Aggregated Channel Bandwidth would accordingly move, requiring possibly some re-arrangement of the CCs.

In neither the "10 % rule" is required for TX/RX filtering nor a single fixed guard band value found feasible for the whole range of CA from 20 … 100 MHz, then a middle and more flexible way could be to make the guard band size a function of the Aggregated Transmission Bandwidth Configuration, with a certain granularity, e.g.:

Table 5.6A-1: Definition of the Guard band size

CA Bandwidth Class	Aggregated Transmission Bandwidth Configuration, N_{RB_agg} [RBs]	Guard band [MHz]
A	$N_{RB, agg} \leq 100$	TBD
B	$N_{RB, agg} \leq 100$	TBD
C	$100 < N_{RB, agg} \leq 200$	[1]
D	$[200] < N_{RB, agg} \leq [300]$	TBD
E	$[300] < N_{RB, agg} \leq [400]$	TBD
F	$[400] < N_{RB, agg} \leq [500]$	TBD

in which *Aggregated Transmission Bandwidth Configuration*, $N_{RB\_ agg}$: The number of aggregated RBs in which a UE can transmit (receive) simultaneously. $N_{RB\_ agg}$ is defined as the sum of the Transmission bandwidth configurations (N_{RB}) of the CCs.

Number of component carriers

In following chapter issues that affect how the CA bandwidths are constructed from individual component carrierss are discussed.

A) Position of DC-Carrier

In REL-8 there is additional sub-carrier inserted in the middle of DL CC which do not contain any data. Reason for this is that to able to do practical receiver designs no data is allocated to sub-carrier which would be located on DC after down conversion. See figure below taken from 36.101.

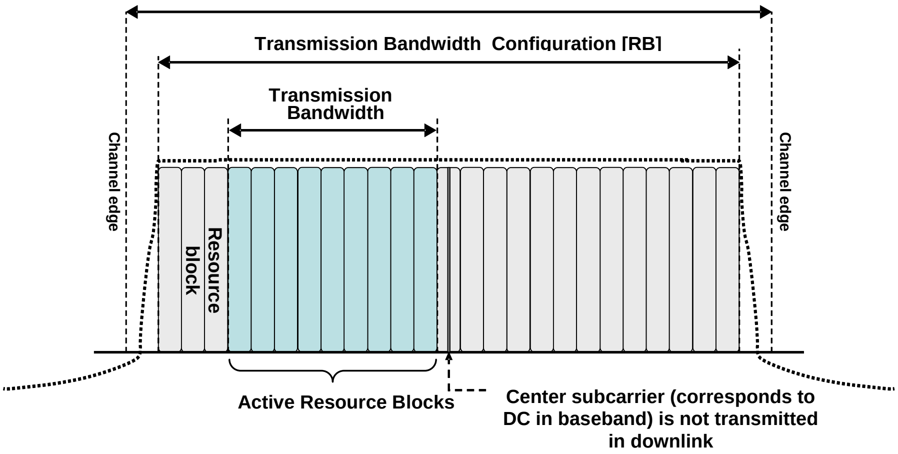


Figure 5.6A-1: Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E UTRA carrier

In order to have this approach also for REL-10 CA the DL Bandwidth combinations in case of intra-band contiguous aggregation shoud be symmetrical in relation to channel centre. That would enable to have unused subcarrier or guard band between the CC to be in zero frequency after down conversions. See figure below.

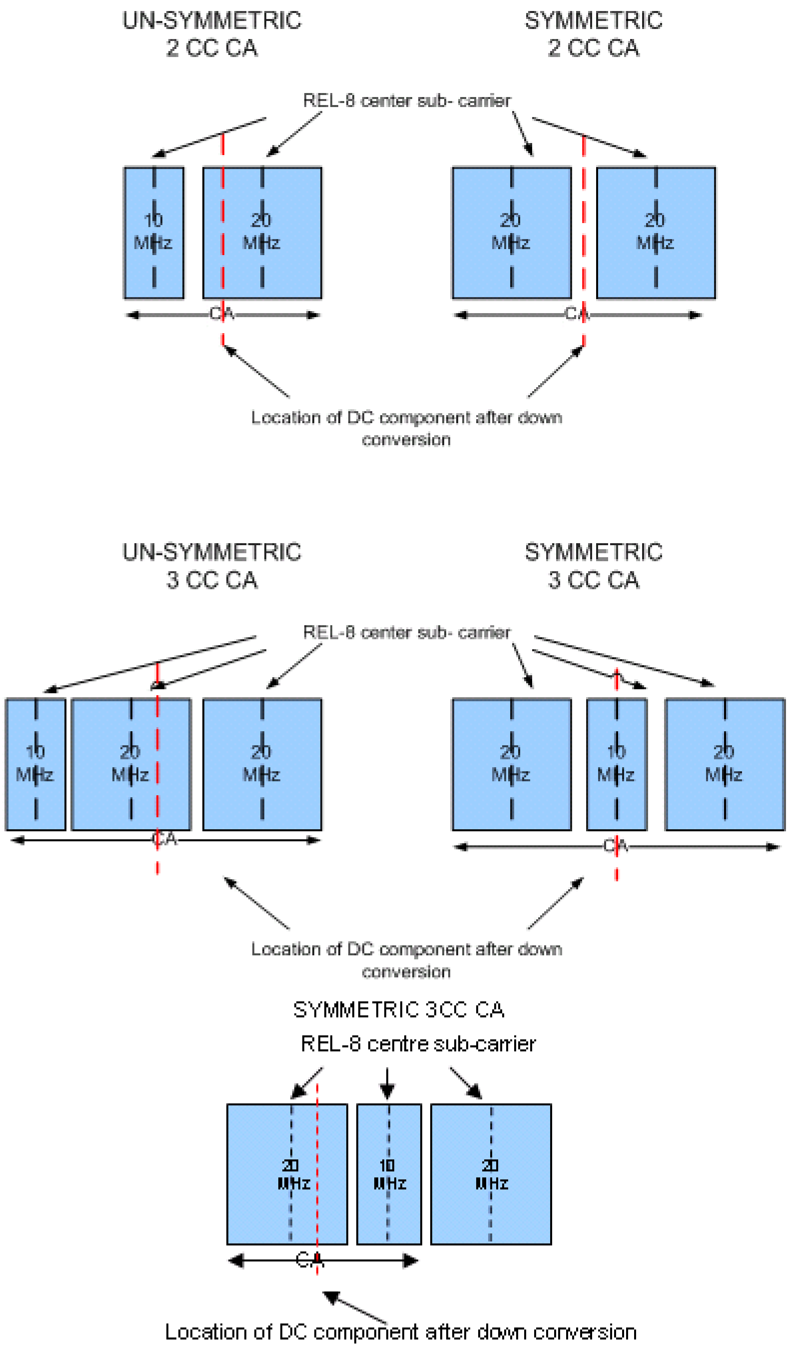


Figure 5.6A-1: Comparison of symmetrical and un-symmetrical CC combinations

From the figure above it can be noticed that if DC allocation is not aligned with the unused sub-carrier DL allocation is not symmetrical in relation to channel centre then some data is probably lost with current receiver architectures. Data loss can be avoided by changing RAN1 spec and allowing unused sub-carrier to be inserted into arbitrary position. This position would depend on quite many variables and is not attractive solution. Data loss is caused by the fact that one sub-cattier is destroyed and this might lead to case where whole resource block is lost. Some implementation solutions can solve or mitigate the DC interference, e.g. not scheduling the affected RBs if the interference is considered to be too high or using lower MCS for the RBs interfered by DC.

B) Different CC combinations that give same CW bandwidth

Certain CA BW's can be achieved with multiple CC combinations. In table below we have taken a look how to construct different CA bandwidths with REL-8 CC's. For the table we have assumed that DL allocation must be symmetrical as explained above.

For example CA bandwidth of 90 MHz can be achieved with three different 5*CC combinations, see table below.

Table 5.6A-2:CC combinations for 90 MHz of CA BW

15+20+20+20+15 = 90 MHz	20+15+20+15+20 = 90 MHz	20+20+10+20+20 = 90 MHz

It would be inefficient from RAN5 testing perspective and overly complex RAN4 specification work perspective to allow total freedom on how CA bandwidths are constructed from CC's.

C) Number of CC's per CA BW Class

In order to keep receiver requirements reasonable we should specify how many CC's are allowed to be used for certain CA bandwidth. This would exclude a possibility to construct 50 MHz BW with 5*10 MHz CC. Instead some combination of 3 CC's should be used.

D) What BWs are allowed to be used in CA

CA CC channel bandwidths follow REL-8 channel bandwidths but there should be possibility to further reduction by allowing only a sub-set of REL-8 BW's.

E) How many different BW's are allowed in multi CC CA

For CA BW classes where more than 2 CC are needed it would seem reasonable to reduce the amount of different BW that are used in CA. Meaning that for example it is not allowed to use 10 MHz, 15 MHz and 20 MHz BW's simultaneously to construct a 45 MHz signal, instead of 3 x 15 MHz should be used. Limit of different BW per CA should be two.

Below we propose a set of terms that shall be followed when new carrier aggregated channel bandwidths are created.

1. Individual component carrier within carrier aggregated channel follow REL-8 transmission bandwidth configurations for a given E-UTRA band but can be further reduced by allowing only a sub-set of those for particular CA operating band

2. Number of component carriers follow CA channel bandwidth Classes defined

3. DL component carrier combinations for a given CA operating band shall be symmetrical in relation to channel centre unless stated otherwise in table 5.6.1A-1 or 5.6.1A-2.

5.6A-3: CA bandwidth classes

CA bandwidth class	Aggregated Transmission Bandwidth Configuration, $N_{RB,agg}$ [RBs]	# CC's
A	$N_{RB,agg} \le 100$	[1]
B	$N_{RB,agg} \le 100$	[2]
C	$100 < N_{RB,agg} \le [200]$	[2]
D	$[200] < N_{RB,agg} \le [300]$	[TBD]
E	$[300] < N_{RB,agg} \le [400]$	[TBD]
F	$[400] < N_{RB,agg} \le [500]$	[TBD]

5.6.1 Channel bandwidths per operating band

5.6.1A Channel bandwidths per CA operating band

CA operating band is further divided into different BW classes by using a notation which indicates to what E-UTRA band and CA channel bandwidth class it relates to. For example

- CA_1B means E-UTRA band 1 and CA channel bandwidth class B.

- In later releases new CA channel bandwidth classes can be introduced by adding new rows in Table 5.6.1-1 or Table 5.6.1-2. For example, CA_1C with 20 MHz as the only allowed channel bandwidth would mean up to 40 MHz wide Carrier aggregation for band 1.

- Notation which do not have CA channel bandwidth class indicator letter means all CA channel bandwidth classes belonging to given CA operating band. For example CA_1 includes CA_1A, CA_1B, CA_1C CA_1D, CA_1E and CA_1F.

Table 5.6.1A-1: E-UTRA CA Intra band contiguous channel bandwidth combinations

E-UTRA band / channel bandwidth							
E-UTRA CA Band	**E-UTRA Bands**	**1.4 MHz**	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
CA_1C	1					Yes	Yes
CA_40C[1]	40				Yes	Yes	Yes
NOTE: Combinations of component carriers with unequal channel bandwidth should be considered. The maximum number of CCs for combination is two for R10.							

Table 5.6.1A-2: E-UTRA CA inter band channel bandwidth combinations

E-UTRA band / channel bandwidth							
E-UTRA CA Band	**E-UTRA Bands**	**1.4 MHz**	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
CA_1A-5A	1			FFS	Yes	FFS	FFS
	5			FFS	Yes		
CA_3A-7A	3				Yes	Yes	Yes
	7				Yes	Yes	Yes
CA_4A-13A	4				Yes		
	13				Yes		
CA_4A-17A	4				Yes		
	17				Yes		

5.6.1B Channel bandwidths per operating band for UL MIMO

For UL MIMO, the channel bandwidths specified in Table 5.6.1-1 in present document apply for the UL-MIMO operating bands listed in Table 5.5B-1.

5.7 Channel arrangement

5.7.1 Channel spacing

R4-102726; Way Forward

1. The channel spacing between centre frequencies of contiguously aggregated component carriers shall be a multiple of 300 kHz for all CA scenarios.

2. Studies for UE RF requirements until next meeting should be focused on 2 values for CC spacing:

    a. Minimum spacing

    b. Close to REL-8 (rounded downwards to 300 kHz grid)

3. The aim is to specify ultimately UE RF requirements for one nominal channel spacing (not excluding other spacing in system deployment)

5.7.1A Channel spacing for intra-band contiguous carrier aggregation

For CA Bandwidth Class C, the nominal channel spacing between two adjacent E-UTRA component carriers is defined as the following:

$$\text{Nominal channel spacing} = \left\lfloor \frac{BW_{Channel(1)} + BW_{Channel(2)} - 0.1\left|BW_{Channel(1)} - BW_{Channel(2)}\right|}{0.6} \right\rfloor 0.3 \quad [\text{MHz}]$$

where $BW_{Channel(1)}$ and $BW_{Channel(2)}$ are the channel bandwidths of the two respective E-UTRA component carriers according to Table 5.6-1 with values in MHz. The channel spacing for intra-band contiguous carrier aggregation can be adjusted to any multiple of 300 kHz less than the nominal channel spacing to optimize performance in a particular deployment scenario.

Nominal CA channel spacing figures for CA bandwidth Class C are listed in table 5.7.1A-1. Values are derived from formula above. UE RF requirements are based on these carrier spacing values

Table 5.7.1A-1 Nominal channel spacing between contiguously aggregated component carriers

Carrier spacing [MHz]		Channel bandwidth $BW_{Channel}$ [MHz] specified in Table 5.6-1					
		1.4	**3**	**5**	**10**	**15**	**20**
Channel bandwidth $BW_{Channel}$ [MHz] specified in table 5.6-1	1.4	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1
	3		Note 1	Note 1	Note 1	Note 1	Note 1
	5			Note 1	Note 1	Note 1	Note 1
	10					12	14.4
	15					15	17.1
	20						19.8
Note 1: FFS, not applicable for REL-10.							

For network deployments also minimum carrier spacing can be used. Minimum carrier spacing values are listed in table 5.7.1A-2.

Table 5.7.1A-2 Minimum channel spacing between contiguously aggregated component carriers

Carrier spacing [MHz]		Channel bandwidth $BW_{Channel}$ [MHz] specified in Table 5.6-1					
		1.4	**3**	**5**	**10**	**15**	**20**
Channel bandwidth $BW_{Channel}$ [MHz] specified in table 5.6-1	1.4	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1
	3		Note 1	Note 1	Note 1	Note 1	Note 1
	5			Note 1	Note 1	Note 1	Note 1
	10					11.4	13.8
	15					13.8	15.9
	20						18.3
Note 1: FFS, not applicable for REL-10.							

For CA Bandwidth Class C, the middle guard band size between two adjacent E-UTRA component carriers is defined as the following:

$$\text{Middle guard band size} = \text{Nominal channel spacing} - \left(N_{RB(1)} + N_{RB(2)}\right)0.09 \qquad [\text{MHz}]$$

Where, $N_{RB\,(i)}$ is the transmission bandwidth configuration of each CC, expressed in units of resource blocks.

Middle guard band sizes of the nominal CA channel spacing for CA bandwidth Class C are listed in table 5.7.1A-3.

Table 5.7.1A-3: Middle guard band sizes for the nominal channel spacing

Middle guard band [MHz]		Channel bandwidth $BW_{Channel}$ [MHz] specified in Table 5.6-1					
		1.4	**3**	**5**	**10**	**15**	**20**
Channel bandwidth $BW_{Channel}$ [MHz] specified in table 5.6-1	1.4	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1
	3		Note 1	Note 1	Note 1	Note 1	Note 1
	5			Note 1	Note 1	Note 1	Note 1
	10					0.75	0.9
	15					1.5	1.35
	20						1.8
Note 1: FFS, not applicable for REL-10.							

Middle guard band sizes of the minimum CA channel spacing for CA bandwidth Class C are listed in table 5.7.1A-4.

Table 5.7.1A-4: Middle guard band sizes for the minimum channel spacing

Middle guard band [MHz]		Channel bandwidth $BW_{Channel}$ [MHz] specified in Table 5.6-1					
		1.4	**3**	**5**	**10**	**15**	**20**
Channel bandwidth $BW_{Channel}$ [MHz] specified in table 5.6-1	1.4	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1
	3		Note 1	Note 1	Note 1	Note 1	Note 1
	5			Note 1	Note 1	Note 1	Note 1
	10					0.15	0.3
	15					0.3	0.15
	20						0.3
Note 1: FFS, not applicable for REL-10							

5.7.2 Channel raster

Basic Channel raster

It is a working assumption in RAN4 that the same channel raster as for E-UTRA REL-8/9 is preserved, thus the carrier centre frequency must be an integer multiple of 100 kHz for all bands.

Proposal: For LTE-A same channel raster as in E-UTRA Rel-9 is applied.

Channel raster for contiguously aggregated CCs

It is a working assumption in RAN4 that spacing between centre frequencies of contiguously aggregated component carriers shall be a multiple of 300 kHz. This is to be compatible with the 100 kHz frequency raster of LTE Rel-8/9 and at the same time to maintain the orthogonality of the subcarriers with 15 kHz spacing.

Orthogonality becomes important when CCs are spaced closely and TX spectrum shaping filtering is not effective any longer. The location on the n*15 kHz raster also facilitates the use of FFT/IFFT across CCs.

Note that most values of the REL-8/9 nominal spacings are not a multiple of 300 kHz. However, as REL-8/9 LTE deployments are typically single-carrier, it's feasible to commence any multi-carrier / CA deployments right away with the channel spacing defined for CA without causing IFHO towards "legacy" carriers. The situation is different in UTRA where DC-HSD(U) PA has to fit into existing multi-carrier deployments and thus the same (5 MHz) channel spacing is required.

Proposal: The nominal channel spacing between centre frequencies of contiguously aggregated component carriers shall be a multiple of 300 kHz for all CA scenarios.

5.7.2A CA Channel raster

For LTE-A same channel raster as in E-UTRA Rel-9 is applied. Hence the channel raster is 100 kHz for all bands, which means that the carrier centre frequency must be an integer multiple of 100 kHz.

5.7.3 Carrier frequency and EARFCN

5.7.4 TX–RX frequency separation

REL-9 requirements are specified for the TX-RX frequency separation as follows:

a) The default E-UTRA TX channel (carrier centre frequency) to RX channel (carrier centre frequency) separation is specified in Table 5.7.4-1 for the TX and RX channel bandwidths defined in Table 5.6-1

Table 5.7.4-1: Default UE TX-RX frequency separation

E-UTRA Operating Band	TX - RX carrier centre frequency separation
1	190 MHz
2	80 MHz
3	95 MHz
4	400 MHz
5	45 MHz
6	45 MHz
7	120 MHz
8	45 MHz
9	95 MHz
10	400 MHz
11	48 MHz
12	30 MHz
13	-31 MHz
14	-30 MHz
17	30 MHz
18	45 MHz
19	45 MHz
20	-41 MHz
21	48 MHz

b) The use of other TX channel to RX channel carrier centre frequency separation is not precluded and is intended to form part of a later release.

In REL-9 LTE, fixed TX-RX frequency separation is a baseline requirement. Generally speaking, if variable TX-RX frequency separation is introduced in the specifications, testing efforts would increase. I.e. if one TX-RX frequency separation is introduced in addition to the fixed one, testing efforts would be almost doubled because many RF requirements, such as reference sensitivity and receiver blocking, would be affected by TX-RX frequency separation.

In REL-10 CA, variable TX-RX frequency separation is definitely required because asymmetric DL/UL assignments would commonly happen. Figure 5.7.4-1 illustrates some examples for such asymmetric DL/UL assignment. It is noted that they could be classified into the following three cases:

- Case 1: Asymmetric in terms of the number of component carriers

  ► Example 1: DL: 2 x 20 MHz, UL: 1 x 20 MHz

- Case 2: Asymmetric in terms of channel bandwidth

  ► Example 2: DL: 2 x 20 MHz, UL: 2 x 10 MHz

- Case 3: Asymmetric in terms of both the number of component carriers and channel bandwidth

  ► Example 3: DL: 2 x 20 MHz, UL: 1 x 10 MHz

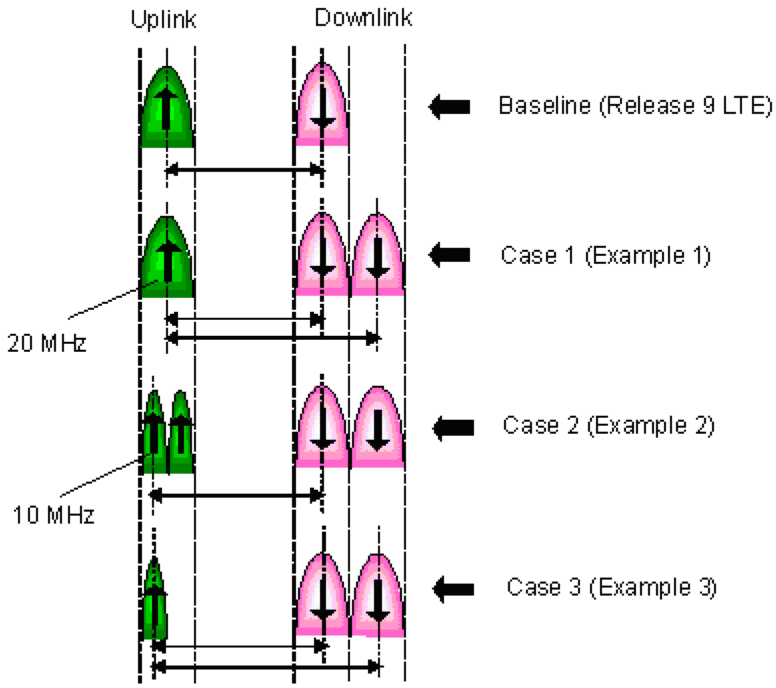


Figure 5.7.4-1

The examples presented in Figure 5.7.4-1 indicate that the number of options for TX-RX frequency separation would significantly increase for CA, if any restrictions would not be introduced. Therefore, some restrictions would be needed in TX-RX frequency separation for CA in order to reduce the testing efforts.

It is proposed that asymmetric DL/UL assignment in terms of channel bandwidth (Case 2/ 3 in Figure 5.7.4-1) should be precluded in REL-10 timeframe, because there would be no essential use cases according to the REL-10 deployment scenarios (See Annex A).

Further analysis on TX-RX frequency separation for Case 1 is provided below:

Symmetrical DL/UL assignment for NW

In case of symmetrical DL/UL assignments for NW, load balancing between two CCs could be achieved by Case 2-1 and Case 2-3 from a primary component carrier point of view, as illustrated in Figure 5.7.4-2. I.e. neither Case 2-2 nor Case 2-4 would be needed. Therefore, it is proposed that TX-RX frequency separation for the primary CC should be limited to the fixed one specified in REL-9. It is noted that additional frequency separation for the primary CC could be introduced in some operation band, if such use cases are identified.

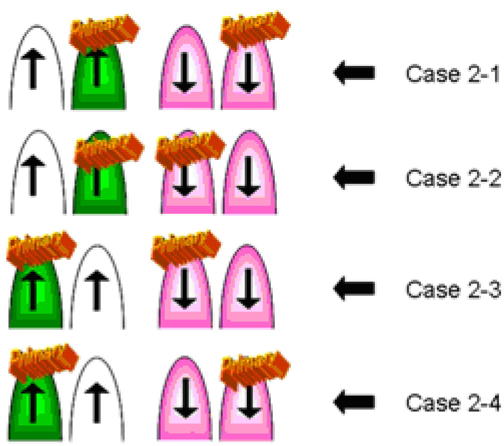


Figure 5.7.4-2

Asymmetrical DL/UL assignment for NW

In case of asymmetrical DL/UL assignments for NW, as illustrated in Figure 5.7.4-3, it is FFS what kind of TX-RX frequency separation should be specified. It should carefully be specified when such asymmetric DL/UL assignments would emerge in the actual network. It is noted that some guidelines to reduce testing efforts should be introduced in such asymmetrical DL/UL assignments.

Figure 5.7.4-3

It is noted that co-existence issues should also be taken into account when TX-RX frequency separation is specified. The minimum and maximum CC TX channel (carrier centre frequency) to RX CC channel (carrier centre frequency) separation is specified in Table below:

Table 5.7.4-2: CA UE TX-RX frequency separation (All CA band classes)

E-UTRA CA Band	E-UTRA Band	TX - RX CC centre frequency separation	
		Min	Max
CA_x	x	tbd MHz	tbd MHz

Noting in this general case the Max TX-Rx spacing would be as per REL8/9 to maintain a fixed duplex distance for the Primary component carrier.

6 Transmitter characteristics

6.1 General

Tx characteristic are specified for the following scenarios:

1) CA_X (Intra band contiguous CA)

2) CA_X-Y (Inter band non contiguous CA)

3) DLMA (Down link multiple antenna)

4) ULMA (Up link multiple antenna)

The UE supporting closed-loop spatial multiplex scheme may be equipped with multiple transmit antennas/antenna connectors. For UE(s) with an integral antenna only, a reference antenna(s) with a gain of 0 dBi is assumed for each antenna port(s). The UE antenna performance has a significant impact on system performance, and the minimum requirements with antenna performance considered are therefore FFS.

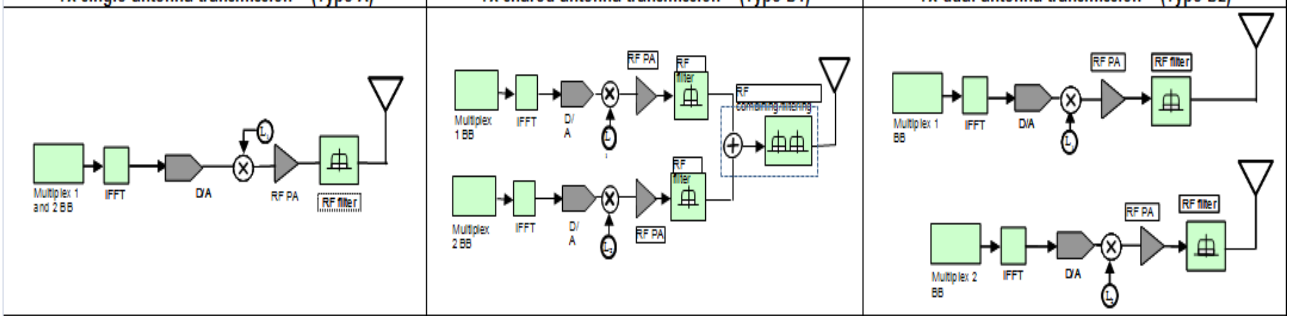
For PUSCH, the UE may be configured in "Single-Antenna Port Scheme" or "Closed-Loop Spatial Multiplexing Scheme" according to TS 36.213. By default, the Rel-8/9 requirements apply to UE in Single-Antenna Port Scheme before eNodeB is aware of the UE transmit antenna configuration. The requirements for Single-Antenna Port Scheme are implementation agnostic.

For UE in Closed-Loop Spatial Multiplexing Scheme, the requirements for different transmitter characteristics in the corresponding sub-clauses may be specified either at each antenna connector or across multiple antenna connectors.

Transmitter requirements for UE with up to two transmitter antenna connectors have higher priority in Rel-10 time frame. It's suggested to test all transmitter requirements for UE with PUSCH in closed-loop multiplexing scheme by configuring the UL spatial multiplex transmission as dual-layer.

1) CPE (Customer Premises equipment)

Figure 6.1-1 illustrates two Tx architectures options as working assumptions:



Tx single antenna transmission ~ (Type A)	Tx shared antenna transmission ~ (Type D1)	Tx dual antenna transmission ~ (Type D2)
Type A1: Intra-band contiguous: Supports a maximum of two release 8 CC carriers (1.4, 3, 5, 10, 15 and 20MHz) Max CA UL bandwidth is 40 MHz	**Type D1-1: Intra-band contiguous:** Supports a maximum of two release 8 CC carriers (1.4,3, 5, 10, 15 and 20MHz) Max CA UL bandwidth is 40 MHz.	**Type D2-1: Intra-band contiguous:** Supports a maximum of two release 8 CC carriers (1.4,3, 5, 10, 15 and 20MHz) Max CA UL bandwidth is 40 MHz. UL MIMO is supported to address ITU-R requirement for peak UL data rate
Type A2: Intra-band non - contiguous: Not supported	**Type D1-2: Intra-band non - contiguous:** Capability of supporting single band non-contiguous in future releases	**Type D2-2: Intra-band non - contiguous:** Capability of supporting single band non-contiguous in future releases
Type A3: Inter-band non -contiguous: Supports a maximum of two release 8 CC carriers (1.4,3, 5, 10, 15 and 20MHz) Simultaneous Tx on both bands is not supported	**Type D1-3: Inter-band non -contiguous:** Supports a maximum of two release 8 CC carriers (1.4, 3, 5, 10, 15 and 20MHz) Max CA UL bandwidth is 20 MHz. Simultaneous Tx on both bands is supported.	**Type D2-3: Inter-band non -contiguous:** Supports a maximum of two release 8 CC carriers (1.4, 3, 5, 10, 15 and 20MHz) Max CA UL bandwidth is 20 MHz. Simultaneous Tx on both bands is supported.

Figure 6.1-1: illustrates Tx architectures working assumptions

Type A: As per TR36.815 can support; CA_X, CA_X-Y, DLMA, and CPE depending on UE capability

Type B: As per TR36.815 for FFS

Type C: As per TR36.815 for FFS

Type D: As per TR36.815 can support; CA_X, CA_X-Y, C DLMA, ULMA and CPE depending on UE capability

6.2 Transmit power

In the study item report TR 25.912 for LTE related to UE maximum output power the following was indicated; It should be possible to reuse the rel-6 PA in order to allow for a single PA implementation for multi-mode (E-UTRA, UTRA) and multi-band terminals and that the E-UTRA UE power class should be a subset of the current UTRA Rel-6 power classes.

However it is not clear if the same requirements would be applicable in the case of dual Tx antenna (separate or dual PA) or CPE. In the case of case of these scenarios, the conducted transmit power may need to be reduced in order to support these larger bandwidths but then the radiated antenna gain is likely to be higher or the cell size would be smaller due to the larger supported data rate. In this case the transmitter characteristic could be defined for a new power class:

- Should the UE class be linked to maximum conducted power
- Should the UE conducted power be linked to the number of Tx antenna (single or dual antenna)

6.2.1 Void

6.2.2 UE Maximum Output Power

Open issues for FFS are:

- How should MPR/ A-MPR be extended for single and/or multiple CC bandwidths
- How should MPR/ A-MPR be extended new power classes and UE classes

Requirements that need to be specified for the single and dual CC for the following;

1) CA_X (Intra band contiguous CA)

R4-102739; Way Forward:

- For intra-band contiguous carrier aggregation the maximum power requirement should apply to the total transmitted power over all CCs (per UE)
- LTE REL-8/9 maximum output power requirements are adopted

2) CA_X-Y (Inter band non contiguous CA)

The maximum output power of an UE is a critical parameter that limits the UL coverage of a network. In principle, it is highly desirable to maintain Rel-8/9 coverage area as much as possible with a reasonable UE cost. As shown in section 6.1, intra-band contiguous carrier aggregation capable UEs could have different Tx architectures compared to a single carrier UE. For type A Tx architecture, a single RF chain is used and for D1/D2 architecture dual RF chains are used to support carrier aggregation. To ensure proper coverage, for all possible Tx architectures, R4-102739.

Way Forward For intra-band contiguous carrier aggregation the maximum power requirement should apply to the total transmitted power over all CCs (per UE).

In the case of single Tx UE, type A Tx architecture could be used. This architecture is the same as a single carrier UE except for a higher channel bandwidth. Given that the Tx bandwidth of a Rel-8/9 PA should cover the whole band, the maximum Tx power over a larger bandwidth within the same band should be not be significantly different. Hence, for intra-band contiguous carrier aggregation.

LTE REL-8/9 maximum output power requirements are adopted. Note that one potential issue that requires more detailed studies is the tolerance for 40 MHz and beyond at the Rel-8/9 maximum output power.

1) DLMA (Down link multiple antenna)

2) ULMA (Up link multiple antenna)

The maximum output power for UE supporting UL-MIMO is defined per UE. This is in accordance with the power control and power management mechanisms in which the total power of the UE from multiple antenna connectors is considered. UE power class is also determined based on the total maximum output power from the UE. The lower tolerance for maximum output power is relaxed due to the multiple transmitters used in closed-loop spatial multiplexing scheme.

3) CPE (Customer Premises equipment)

6.2.3 UE Maximum Output power for modulation / channel bandwidth

Channel arrangement

In this chapter we present results of MPR study for an aggregated signal with the following settings:

- Total Aggregated Transmission Bandwidth Configuration: 100 + 100 RB, 75+75 RB and 50+100 RB
- Component Carrier Spacing as defined in [1]: 19.8 MHz (for 100+100 RB case), 15.0 MHz (for 75+75 RB Case) and 13.8 MHz (for 50+100 RB Case)
- Guard bands are set to 1 MHz on either side of the aggregated channel bandwidth (for 100+100 RB case),0.75 MHz (for 75+75 RB case) and 1 MHz (for 50+100 RB case)
- Data Modulation: QPSK and 16QAM
- RB allocations: contiguous i.e. no empty RB's between transmitted clusters
- RB_Start is always 0

Simulation assumptions

Simulation assumptions used are listed in Table 6.2.3-1. PA operating point was set so that for one fully allocated (100RB) carrier (LTE Rel-8 carrier) the reported $UTRA_{ACLR1}$ level was 33 dB when 1 dB of MPR was applied as permitted by the specification 36.101. Backoff and MPR values are referred to this PA operating point.

Table 6.2.3-1: RF settings

Power amplifier operating point	
$UTRA_{ACLR1}$ for Rel8 carrier	33 dB
Modulator impairments	
IQ-Imbalance	25 dB
Carrier leakage	25 dB
3rd order Counter-IM level	60 dB

Target requirements

Following ACLR and SEM requirements were used when required backoff (MPR) was searhed. These requirements are inline with the agreements done during previous RAN4 meetings.

- $E\text{-}UTRA_{ACLR}$ = 30 dBc
- $UTRA_{ACLR1}$ = 33 dBc
- $UTRA_{ACLR2}$ = 36 dBc
- CA $E\text{-}UTRA_{ACLR}$= 30 dBc

Table 6.2.3-2: Spectral emission masks, from [1], Table 6.6.2.1A-1

Spectrum emission limit [dBm]/$BW_{Channel\_CA}$			
Δf_{OOB} (MHz)	30 MHz	39.8 MHz	Measurement bandwidth
± 0-1	-22.5	-24	30 kHz
± 1-5	-10	-10	1 MHz
± 5-30	-13	-13	1 MHz
± 30-35	-25	-13	1 MHz
± 35-39.8		-13	1 MHz
± 39.8-44.8		-25	1 MHz

Simulation results

Results are presented in a form of a graphs Figures 6.2.3-1 and 6.2.3-2 and a Table 6.2.3-3.

From the Figures 6.2.3-1 and 6.2.3-2, it can be seen that as the total number of RBs in the contiguous allocation increases, the criterion that determines the maximum backoff needed changes. This trend is depicted in Figure 6.2.3-1 for 100+100 RB allocation and Figure 6.2.3-2 for 75+75 RB allocation.

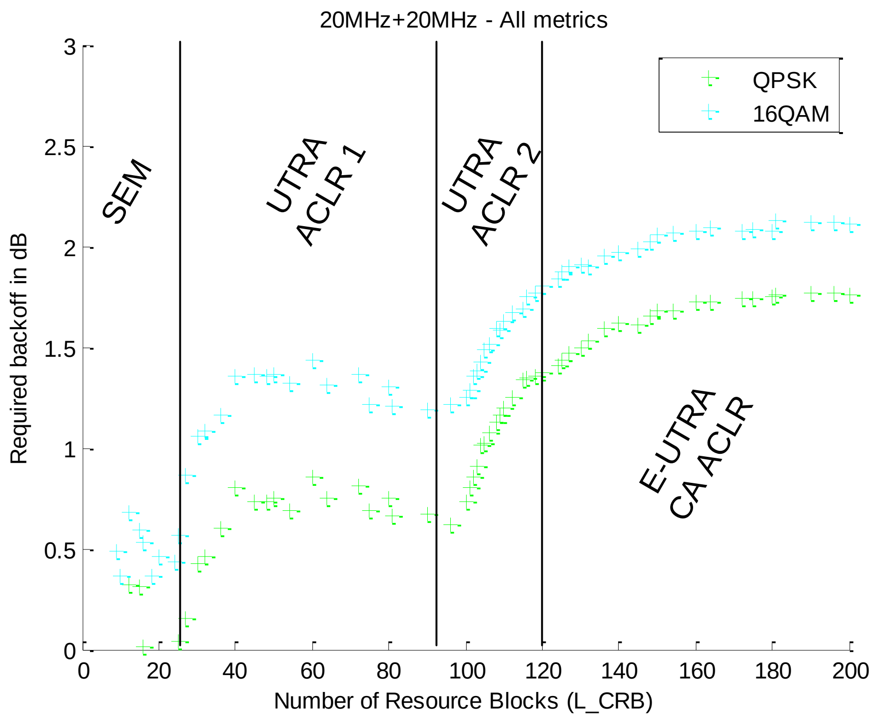


Figure 6.2.3-1: Criteria impacting the MPR requirement (100+100 RB)

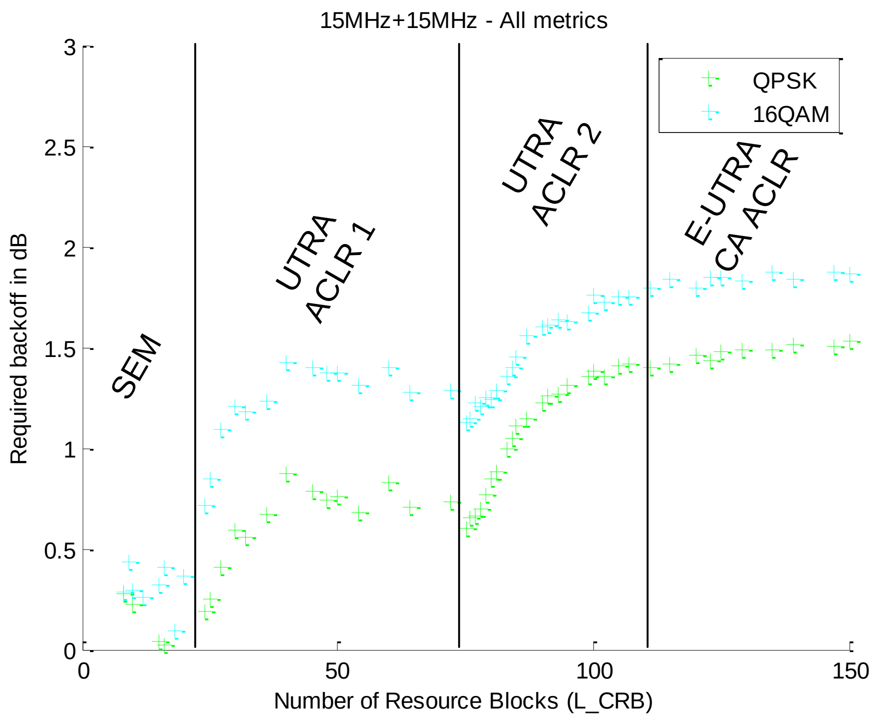


Figure 6.2.3-2: Criteria impacting the MPR requirement (75+75 RB)

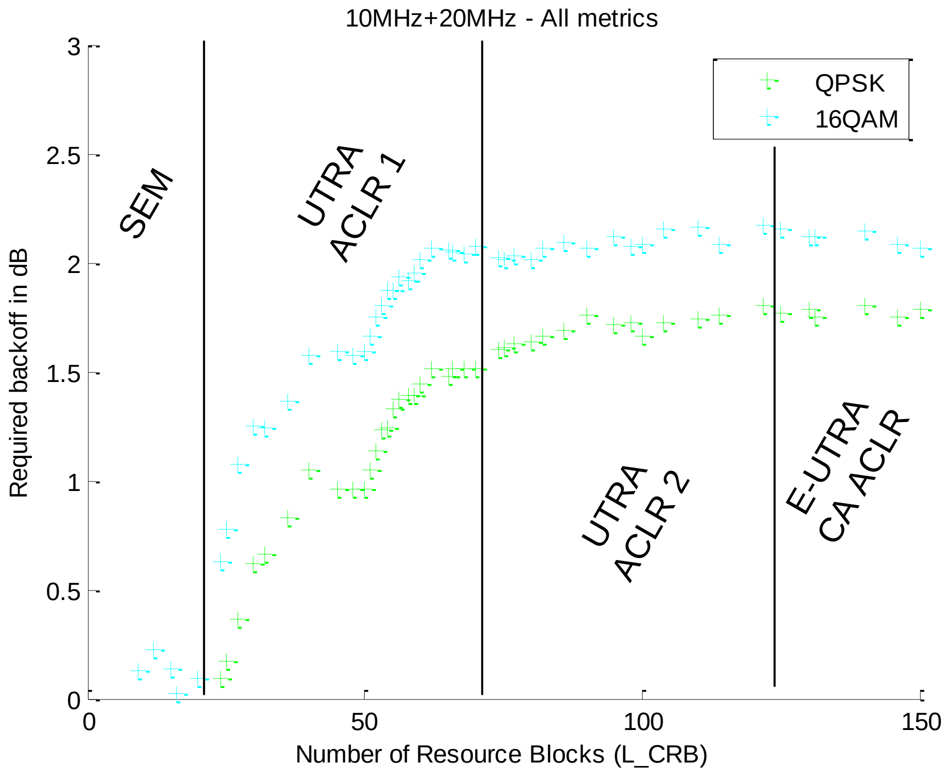


Figure 6.2.3-3: Criteria impacting the MPR requirement (50+100 RB)

Table 6.2.3-3 below summarises the required backoff needed to satisfy the Tx requirements as a function of number of RBs for both QPSK and 16-QAM signals.

Table 6.2.3-3: Required MPR as function of number of RBs

Total number of RBs	Backoff needed 100+100 RB		Backoff needed 75+75 RB		Backoff needed 50+100 RB	
	QPSK	16-QAM	QPSK	16-QAM	QPSK	16-QAM
0-20	0.32	0.68	0.28	0.44	0	0.22
21-40	0.8	1.35	0.87	1.42	1.05	1.58
41-60	0.86	1.43	0.83	1.4	1.44	2.01
61-80	0.81	1.36	0.85	1.29	1.64	2.07
81-100	0.73	1.25	1.38	1.76	1.76	2.11
101-120	1.37	1.8	1.46	1.83	1.76	2.17
121-140	1.62	1.97	1.51	1.87	1.81	2.17
141-160 (1)	1.72	2.08	1.53	1.87	1.79	2.09
161-180	1.75	2.09	N/A	N/A	N/A	N/A
181-200	1.77	2.13	N/A	N/A	N/A	N/A
(1) The values are applicable only till total number of RBs = 150						

Contiguous allocation in this contribution refers to case where no empty RB's are located within an UL allocation. This is not a typical network behaviour because in most cases there will be PUCCH regions reserved for other UE's to send uplink control information. These PUCCH regions that will break the contiguous nature of the allocation are the higher edge PUCCH of the lower carrier and the lower edge PUCCH of the higher carrier which are located in the middle of the aggregated signal. As a corner case it is how ever possible to schedule full bandwidth to a single UE without PUCCH regions.

It should be also noted that even though called contiguous allocation in this paper the allocations wide enough to extend to second carrier are not single carrier transmissions therefore the PAR and the cubic metric are increased and hence more MPR is required compared to truly single carrier transmission.

When the aggregated transmissions bandwidth configuration is such that it allocates RB's from two component carriers then the needed backoff increases strongly and this can be observed easily from the figures 1-5 and from table 1. As an example this means than if a UL signal having size of 100 RB is allocated into two CC each having bandwidth of 15 MHz then more MPR is needed than for single carrier signal consisting of a single CC having bandwidth of 20 MHz.

Also in the case where the allocation is limited to single carrier (Pcc) and the other carrier (Scc) do not contain transmissions but the Tx is configured to 2 CC mode one cannot directly compare the required MPR or emissions to release 8/9 operation because the Tx bandwidth is wider and the carrier leakage and IQ-image components are located differently compared to truly single carrier transmission specified in REL-8/9. This will cause a fact that the IMD products generated in PA are located differently in OOB and spurious regions when one compares carrier aggregated signal to REL-8/9 signal even though the allocation size would be same and it would be located on a same position on single carrier.

6.2.3.1 MPR for multi cluster allocations

Issues that affect required MPR

As noted in earlier studies defining a MPR scheme for non-contiguous multi-cluster LTE transmission is challenging because there are many dimensions in the signal that affect the required back off. In Figure 6.2.3.1-1 we illustrate some of the parameters that affect the MPR. The following notation applies:

G = the maximum gap between two adjacent RB clusters
A_n = the width of the nth cluster allocation
E_L = the distance from the edge of the first cluster to the left hand edge of the first component carrier
E_R = the distance from the edge of the last cluster to the right hand edge of the last component carrier
W = the distance from the left hand edge of the first cluster to the right hand edge of the last cluster

In all cases the units are normalised to the total number of RBs in both component carriers and therefore take values from 0 to 1. (The Edge allocations, E_L and E_R are actually normalised to N_{RB} / 2 such that the final value of E (defined subsequently) will be in the range 0 to 1).

As examples:

1) An allocation that extended the full width of both component carriers would have a width W=1.

2) A 15 RB cluster in a 75+75 component carrier configuration would have $A_n = 15 / (75+75) = 0.1$.

We further define the following parameters:

$A = sum(A_{1,\ldots,}A_n)$ (i.e. the total RB allocation across all clusters).
$E = min(E_L, E_R)$ (i.e. the minimum distance from the edge of the outside clusters to the edge of the CCs).
$B = abs(A_1 – A_N)$ (i.e. the difference between the RB allocations of the two edge clusters).

This yields the five key parameters, G, A, E, W and B that can be used to parameterise the backoff.

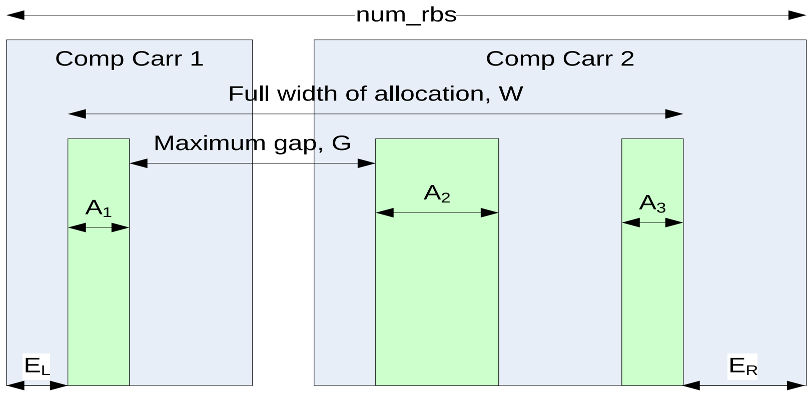


Figure 6.2.3.1-1: Parameters affecting MPR

Simulation campaign

During the simulation campaign a large set of allocation scenarios were simulated and appropriate MPR value was searched. The method used to define these allocations was initially as described in R4-110265; to increase the coverage of the simulations a number of random scenarios were added in each case. Table 6.2.3.1-1 shows the minimum number of scenarios that were simulated for each component carrier configuration. In some cases additional simulations for other random configurations were also carried out.

Table 6.2.3.1-1 :Simulation Minimum number of simulation scenarios

Number of clusters	**2**	**3**	**4**	**5**
CC bandwidths				
10 MHz+20 MHz	3235	1819	1654	1605
15 MHz+15 MHz	3242	2048	2220	1435
20 MHz+20 MHz	2801	2894	1819	1270

Simulations were carried out using two different PA models, such that the total number of configurations simulated was 110131. Simulation assumptions were as follows:

- PA operating point REL-8 20 MHz CC $UTRA_{ACLR1}$=33 dBc with Pout = 22 dBm
- Modulator IQ – image = 28 dB
- Modulator carrier leakage = 28 dBc
- Modulator C_IM3 = 60 dBc

Note that the modulator IQ leakage and carrier leakage have been modified to 28 dBc; this is because the in-band mask limits for carrier and image breakthrough are both 25 dBc, which led to most simulations providing marginal failures on the in-band mask with the earlier simulation assumption of 25 dBc (e.g. R4-10104335, R4-110265).

PA operating point was set so that for one fully allocated (100RB) carrier (LTE Rel-8 carrier) the reported UTRAACLR1 level was 33 dB when 1 dB of MPR was applied as permitted by the specification 36.101. Backoff and MPR values are referred to this PA operating point.

In-band mask definition

As yet, the in-band mask has not been defined for aggregated carriers; however in order to have something to benchmark the performance of the MPR rules, an initial definition of in-band was assumed. This definition is overly-complex in order to provide something that is coherent with the Release-8 in-band mask definition. It is *not* proposed that this definition be used in the RF specification for LTE.

The definition for the mask is as given in table 6.2.3.1-2:

Table 6.2.3.1-2: Annotated parameters for in-band emission calculation

General	dB	$G = \max\{G_1, G_2, G_3\}$ where $G_1 = -25 - 10 \cdot \log_{10}(N_{RB} / L_{RB})$, $G_2 = \text{power\_sum}(G_{2,n})$, $G_3 = -57\, dBm / 180kHz - P_{RB}$, $G_{2,n} = 20 \cdot \log_{10} EVM - 3 - 5 \cdot (\lvert\Delta_{RB,n}\rvert - 1) / L_{CRB,n}$		Any non-allocated
IQ Image	dB	I = -25		Image frequencies
Carrier leakage	dBc	C = -25	Output power > 0 dBm	Carrier frequency
		C = -20	-30 dBm ≤ Output power ≤ 0 dBm	
		C = -10	-40 dBm ≤ Output power < -30 dBm	
Global floor	dBm	$F = P_{RB}$ -30 dB		

The major differences are that:

1. The G_2 term is now a power sum of the $G_{2,n}$ terms defined for each of the individual clusters.
2. The carrier leakage requirement is relative to the complete allocated RB power.
3. Depending on the CC bandwidths and the frequency separation, the carrier may appear between two RBs, within one RB or in the gap between CCs. In the case of a symmetric allocation, the carrier will appear between the CCs.
4. The CC raster for Release 10 is 300kHz (the least common multiple of 15 kHz and 100 kHz). This is not an exact number of RBs – therefore in carrier aggregation, A_n RBs on one side of the spectrum may impact on A_n +1 "image" RBs on the other side of the allocation. Image RBs are therefore defined as any RBs which overlap with the image of allocated RBs.
5. The $\Delta_{RB,n}$ term will skip values in the spacing between the CCs and, where the carrier spacing is not an exact number of RBs, it will take non-integer values for RBs that are in the CC that cluster n is not allocated in.
6. One significant advantage of this algorithm is that, in the single CC case, it collapses down to the Rel-8 algorithm.

A particularly complex example of an in-band mask for 5 clusters can be seen in Figure 6.2.3.1-2, with the limit line shown in red. The example is for a 10+20 MHz CC configuration, so that the carrier breakthrough region occurs in-band; the increased limit in the image regions can be seen on the right hand side.

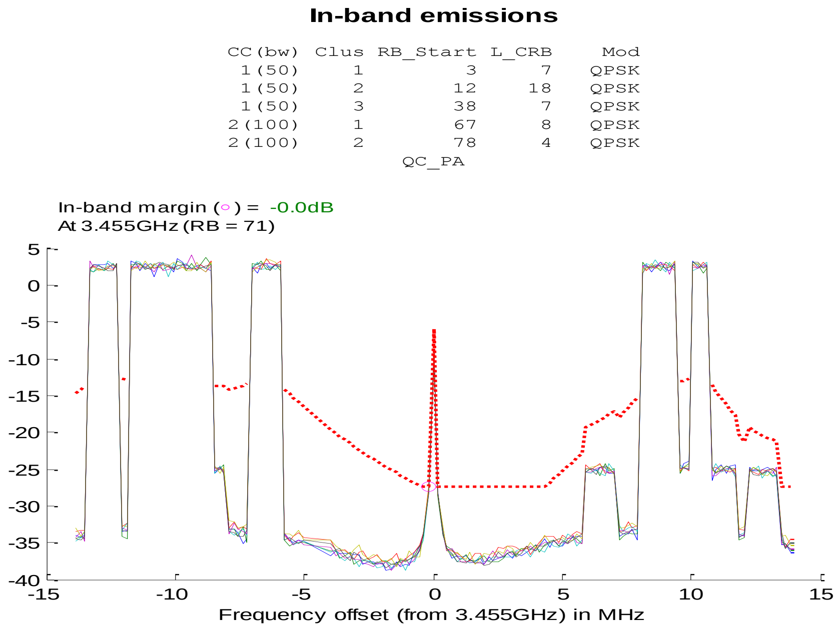


Figure 6.2.3.1-2: In-band mask example

Method to define the MPR

Allocation ratio – previously defined mask

The method proposed in R4-110265 was termed the allocation ratio and is referred in chapter 2.1 as A = sum(A_1, A_N) (i.e. the total RB allocation across all clusters) – normalised to the total number of RBs. Figure 6.2.3.1-3 is a recapture from R4-110265 and shows the allocation mask proposed for the backoff. This original "stepped" mask was proposed to keep the mask definition as simple as possible. This figure shows data for only two clusters and doesn't include the in-band mask as a criterion for defining the backoff.

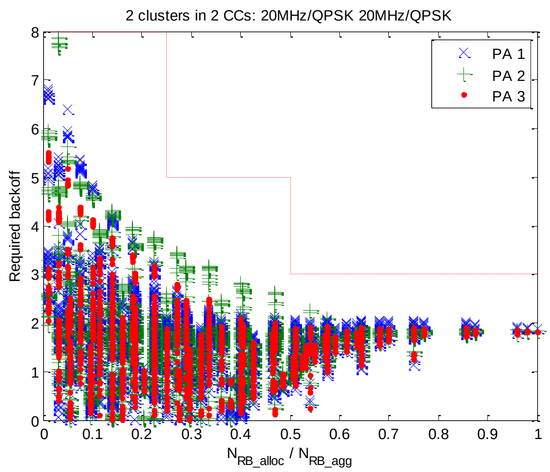


Figure 6.2.3.1-3: N_{RB_alloc} / N_{RB_agg} vs. MPR

The method proposed in R4-110265 had a one disadvantage which was also pointed out in discussions in RAN4 meeting #57AH Austin. That was the fact as the mask was optimised to be as simple as possible it meant that there was unnecessary excess backoff allowed for many allocations.

Note that in the above figure, there are some extreme scenarios that require up to 8 dB of backoff for very narrow allocations for the PA2 model. It was found in the current set of simulations, that the PA2 model required significantly more backoff than the other 2 PAs for a wider range of scenarios. This PA is a W-CDMA model and is therefore not optimised for LTE signals. It is therefore not considered representative and this PA has been excluded from the current study.

Allocation ratio – refined mask

In 6.2.3.1-4 there is a proposal for more optimised mask where the limit line is more complicated but allows for lower excess backoff for the various scenarios. In this and all subsequent figures, the data shown is the aggregate of all simulation scenarios for 2 to 5 clusters and for both PAs. It also includes the in-band mask.

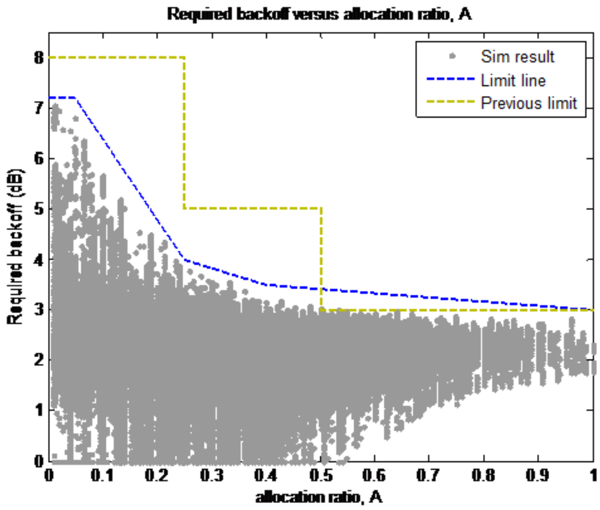


Figure 6.2.3.1-4: New allocation ratio mask proposal

Gap ratio

Plotting the same backoff data against the gap ratio, G, defined in earlier Section, yields the profile shown in Figure 6.2.3.1-5.

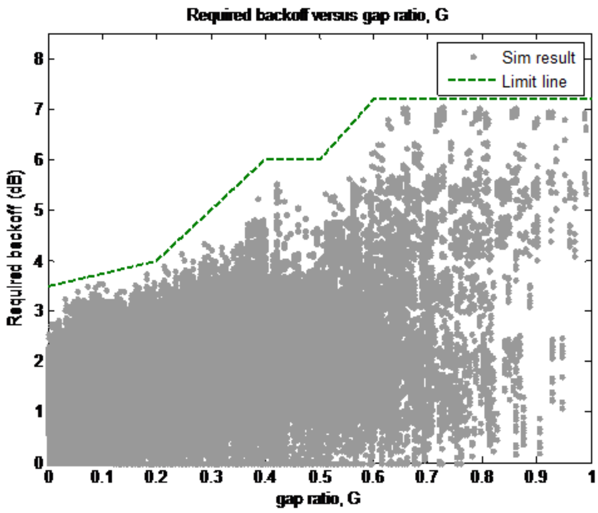


Figure 6.2.3.1-5: Gap ratio with possible mask

Edge ratio

Plotting the same data again but versus the edge ratio, E, defined above, yields the profile shown in Figure 6.2.3.1-6.

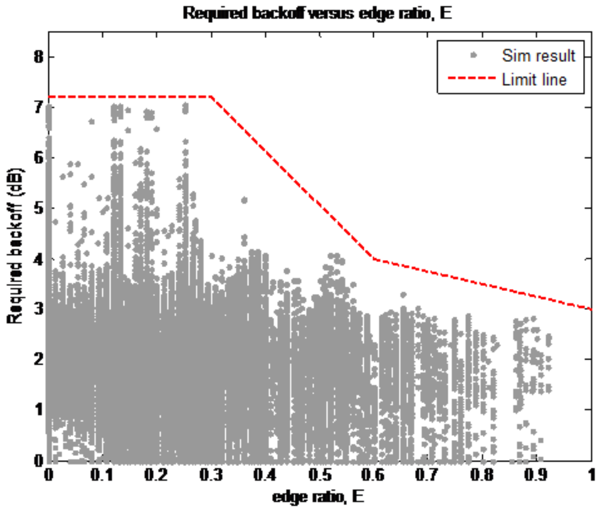


Figure 6.2.3.1-6: Edge ratio with possible mask

Balance ratio

Finally, we plot the data against the balance ratio, B, defined in earlier section.

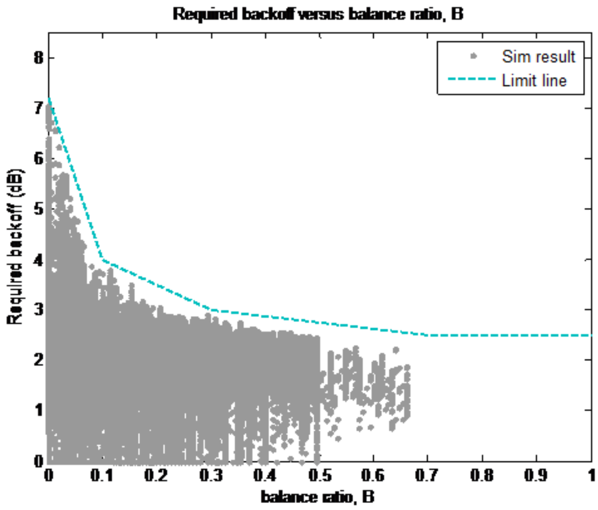


Figure 6.2.3.1-7: Balance ratio with possible mask

Using a formula to define backoff

Another approach that was tried was to look at directly determining a set of coefficients for the various ratios that would provide acceptable performance. The search was for an equation of the form:

$$MPR = c_1 + c_2A + c_3G + c_4W + c_5E$$

where c_1 to c_5 are fixed coefficients and the A, G, W and E are the parameters defined in earlier section. The minimum and maximum values of the equation were "clipped" to 0 dB and 7 dB. The challenge was to find an equation that minimised the excess backoff (i.e. the difference between MPR determined by the above equation and backoff determined through simulation) for the largest number of simulation points.

A manual search was used initially, but this proved rather challenging so instead a MonteCarlo approach was used with a large number of random coefficients being tried, and the best set of coefficients selected at the end.

A set of 23,000,000 sets of coefficients was tried with the following equation providing the "best" solution:

One possibility is: $MPR = 3 - 6.5A + G + 6W - 1.2E$

Note however that this is not a unique solution, a large number of solutions were developed providing very similar results with radically different coefficients. This indicates that the problem is under-determined.

Comparison of CDF curves

In order to compare the various approaches and masks, the excess backoff was determined for each data point and for each backoff method/metric and the CDF of this excess backoff was plotted for each method.

The excess backoff is defined as the MPR determined using the chosen metric (i.e. allocation ratio, gap ratio, equation, etc) minus the backoff required derived from the simulation result.

The CDFs are shown in figure 6.2.3.1-8. It can be seen that the best metric is the allocation ratio with the new mask shown in 6.2.3.1-4, for which around 20% of the points have less than 1.2 dB of excess backoff, 50% have less than 2 dB of excess backoff and around 70% have less than 3 dB of excess backoff.

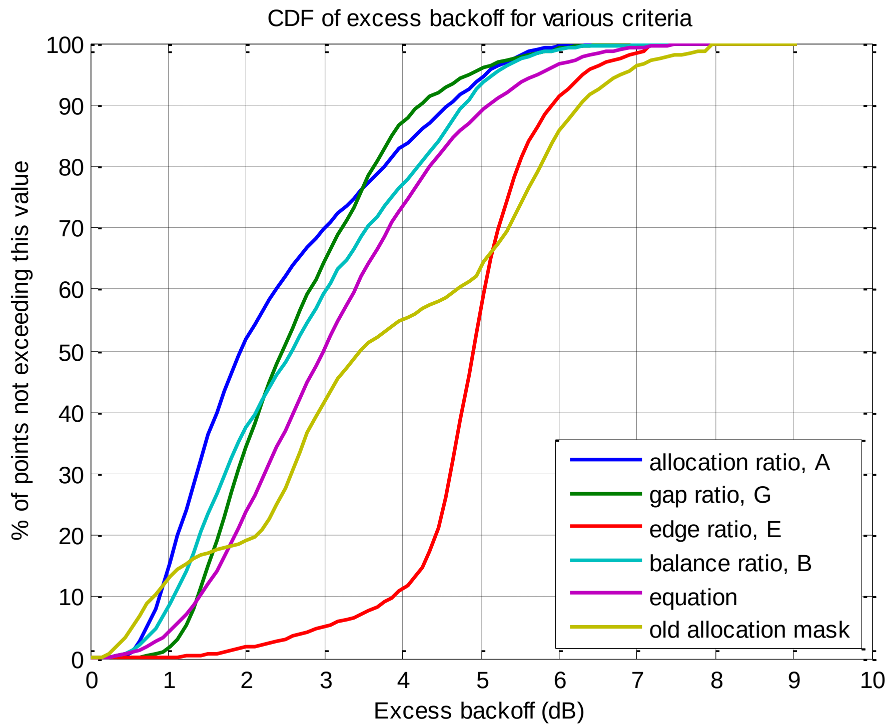


Figure 6.2.3.1-8: CDF of excess backoff for each method/metric

If we further assume that with aggregated carriers, it is unlikely in a practical deployment to use only a few small allocations, it seems reasonable to look at the CDF with allocation ratios of less than 0.1 excluded. The results for this are shown in figure 6.2.3.1-9 and it is clear the proposed allocation ratio mask provides less than 2 dB of excess backoff for 60% of the time and less than 3 dB of excess backoff for 70% of the scenarios.

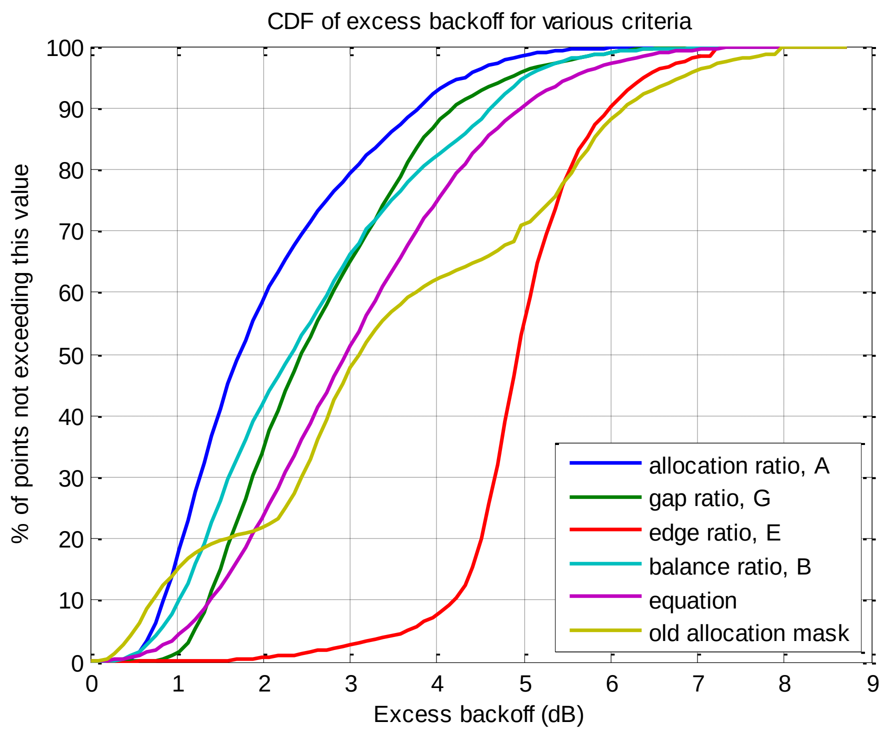


Figure 6.2.3.1-9: CDF of excess backoff for each method/metric – excluding narrow allocations

Conclusion

Based on a large number of simulation points it is proposed that a single metric be used to determine the required MPR. The proposed metric is the allocation ratio, written formally as N_{RB_alloc} / N_{RB_agg}, where N_{RB_alloc} has not been specified yet but refers to sum of active (transmitted) RBs when taking into account all clusters.

The proposed MPR mask is generated by the linear interpolation between the following points:

A = N_{RB_alloc} / N_{RB_agg}	0	0.05	0.25	0.4	1
Mask limit (dB)	7.2	7.2	4	3.5	3

And can be written formally as:

$$
\begin{aligned}
MPR &= 7.2, & 0 < A \le 0.05 \\
&= 8 - 16A, & 0.05 < A \le 0.25 \\
&= 4.83 - 3.33A, & 0.25 < A \le 0.4 \\
&= 3.83 - 0.83A, & 0.4 < A \le 1
\end{aligned}
$$

For UL-MIMO:

By reusing the Rel-8/9 MPR for the maximum output power of the UE supporting UL-MIMO, the same or better coverage than Rel-8/9 network can be guaranteed.

RAN4 has the agreement that UE supporting UL-MIMO may have multiple implementation options which imply the maximum output power capability of each transmitter might have different options. The UE supporting UL-MIMO may employ a cost effective implementation scheme by selecting multiple "smaller" PA(s) comparing with single transmitter UE in the same power class. The least MPR value required would be the implemetation structure with two 23 dBm PA(s) while the largest MPR values would be required when two 20 dBm PA(s) are used. In order to meet the ACLR requirements, the difference between the Rel-8/9 MPR and the required MPR in case of two 20 dBm PA(s) would be small. Furthermore, the MPR requirement is specified as an up limit. For UE supporting UL-MIMO with multiple transmitters, design buffer for trade-off between emission/maximum output power/power consumption might be considered. Vendors may not apply any MPR value depending on their particular design optimizations. Considering the same or better network coverage than Rel-8/9 can be guaranteed, it is suggested to apply the same Rel-8/9 MPR (due to higher order modulation and transmit bandwidth) to the total maximum output power of the UE supporting UL-MIMO.

6.2.3.2 MPR mask for single component carrier

The required MPR mask is determined by meet UE Tx requirements such as ACLR, SEM and SE requirements. The basic RF simulation assumptions and parameters are given below;

- Basic simulation assumption and parameters for single CC
  - Support Rel-8/9 compatible Channel Bandwidth.
  - Modulation schemes : QPSK/16-QAM
  - Modulator impairments
    - I/Q imbalance : 25 dBc
    - Carrier leakage: 25 dBc
    - Counter IM3 : 60 dBc
  - ACLR requirement

Table 6.2.3.2-1

Channel arrangement	Minimum channel spacing with 1 MHz Guard band
$UTRA_{ACLR1}$	33 dB
Adjacent channel centre[1] frequency offset (in MHz)	$+10+BW_{UTRA}/2$ / $-10-BW_{UTRA}/2$
$UTRA_{ACLR2}$	36 dB
Adjacent channel centre[1] frequency offset (in MHz)	$+10+3*BW_{UTRA}/2$ / $-10-3*BW_{UTRA}/2$
UTRA5 MHz channel[1] Measurement bandwidth	3.84 MHz
$E\text{-}UTRA_{ACLR}$	30 dB
Adjacent channel centre[1] frequency offset (in MHz)	+20 / -20
E-UTRA channel[1] Measurement bandwidth	18 MHz

Table 6.2.3.2-2: General E-UTRA SEM for Rel-8/9

Spectrum emission limit (dBm)/ Channel bandwidth							
Δf_{OOB} (MHz)	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz	Measurement bandwidth
± 0-1	-10	-13	-15	-18	-20	-21	30 kHz
± 1-2.5	-10	-10	-10	-10	-10	-10	1 MHz
± 2.5-2.8	-25	-10	-10	-10	-10	-10	1 MHz
± 2.8-5		-10	-10	-10	-10	-10	1 MHz
± 5-6		-25	-13	-13	-13	-13	1 MHz
± 6-10			-25	-13	-13	-13	1 MHz
± 10-15				-25	-13	-13	1 MHz
± 15-20					-25	-13	1 MHz
± 20-25						-25	1 MHz

Table 6.2.3.2-3: Spurious Emission requirement for RF simulation

Frequency Range	Maximum Level	Measurement Bandwidth
9 kHz ≤ f < 150 kHz	-36 dBm	1 kHz
150 kHz ≤ f < 30 MHz	-36 dBm	10 kHz
30 MHz ≤ f < 1000 MHz	-36 dBm	100 kHz
1 GHz ≤ f < 12.75 GHz	-30 dBm	1 MHz

Simulation campaign

As the same with the multi-cluster MPR in section 6.3.2.1, the allocation ratio is used to determine the MPR mask of multi-clustered simultaneous transmission in single component carrier.

In first step, the required MPR mask in single component carrier are achieved in the general case, then additional MPR mask for NS_XX are determined when there are additional requirements.

Conclusion

Based on a large number of simulation points it is proposed that a single metric be used to determine the required MPR. The proposed metric is the allocation ratio, written formally as N_{RB_alloc} / $N_{RB\_agg.}$ where N_{RB_alloc} has not been specified yet but refers to sum of active (transmitted) RBs when taking into account all clusters.

The proposed MPR mask for general case using general SEM and SE is generated by the linear interpolation between the following points:

A = N_{RB_alloc} / N_{RB_agg}	0	0.33	0.77	1
Mask limit (dB)	8.0	4.66	3.31	3.31

$$MPR = 8.0-10.12A, \quad 0< A \leq 0.33$$

$$= 5.67-3.07A, \quad 0.33< A \leq 0.77$$

$$= 3.31, \quad 0.77< A \leq 1.0$$

MPR mask for single component carrier

A large number test points for 20 MHz intra frequency for CA transmission are simulated. Each of the waveforms contains two clusters of varying width and equal power spectral density in each RB. The RB positions and widths are randomized. For each waveform the MPR is calculated considering the General E-UTRA spectrum emission mask, ACLR and spurious emissions.

For QPSK/16-QAM, the MPR limit is plotted against the allocation ratio metric in the figure below:

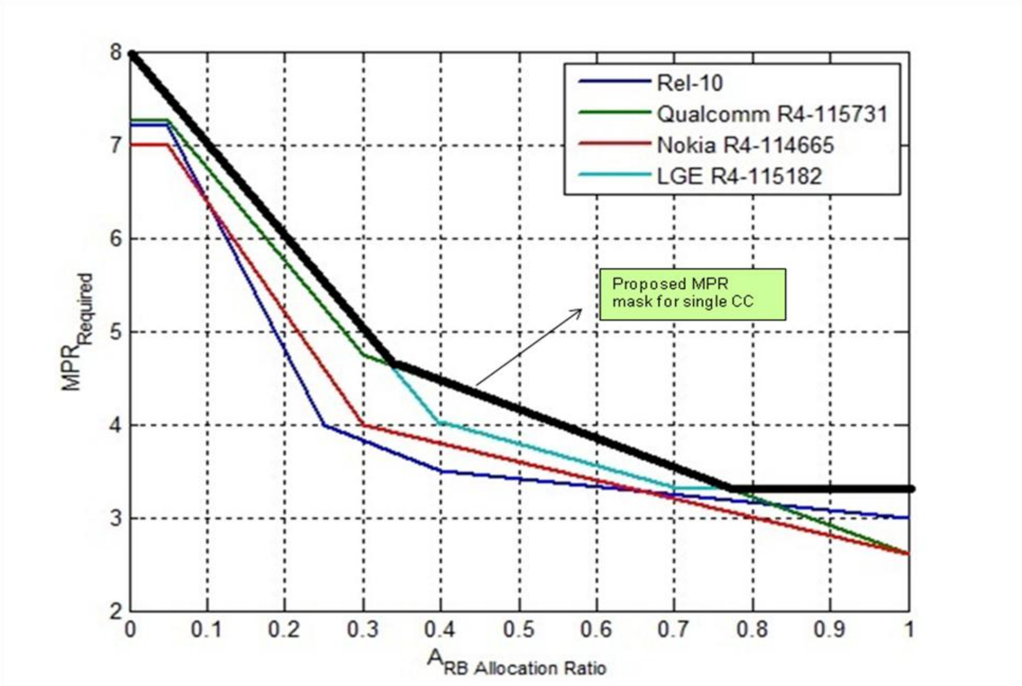


Figure 6.2.3.2-1: Multi-clustered simultaneous transmission simulation results using general SEM and SE for Single CC

Each of the plots above has a possible MPR limit (without the 0.5 dB quantization) shown.

The MPR can be expressed mathematically as follows

$$MPR = CEIL\ \{M_{A,}\ 0.5\}$$

$$M_A = 8.0\text{-}10.12A, \quad 0< A \leq 0.33$$

$$= 5.67\text{-}3.07A, \quad 0.33< A \leq 0.77$$

$$= 3.31, \quad 0.77< A \leq 1.0$$

Where **A = N_{RB_alloc} / N_{RB_agg}.**

6.2.4 UE Maximum Output Power with additional requirements

Open issues for FFS are:

- How should MPR/ A-MPR be extended for single and/or multiple CC bandwidths
- How should MPR/ A-MPR be extended new power classes and UE classes

Note the current RAN1 assumption assumes in the case of contiguous CC carriers then RB can be freely allocated for the different CC carriers.

For UL-MIMO:

The UE supporting UL-MIMO shall meet the additional ACLR and spectrum emission requirements signalled by the network in a specific deployment scenario. To meet these additional requirements, Additional Maximum Power Reduction (A-MPR) is allowed for the total output power of the UE supporting UL-MIMO. Unless stated otherwise, an A-MPR of 0 dB shall be used.

The same Rel-8/9 A-MPR values apply to the total output power of the UE supporting UL-MIMO in the UL-MIMO operating band.

6.2.5 Configured transmitted Power

Another area for study is whether the multi-CC UL signal is combined digitally (at the baseband) or in analogue (at IF or RF) since the configured accuracy in terms of accurate power control ratio amongst different CC will be less precise due to the analog component in the RF chain.

For UL-MIMO:

The output power of the UE with multiple transmit connectors are controlled by the network by considering the total output power. The configured transmitted power for UL-MIMO shall also be based on total output power.

For UL MIMO, the same definitions of configured maximum output power P_{CMAX}, the lower bound P_{CMAX_L}, and the higher bound P_{CMAX_H} which are specified in Section 6.2.5 in TS 36.101 shall apply to UE with multiple transmit antenna connectors, wherein the requirements of $P_{PowerClass}$, MPR, and A-MPR shall be the ones specified in the corresponding the sub-clauses for UL-MIMO.

There are two contributors to the errors for measured P_{CMAX}:

1) The power estimate errors

2) The errors due to multiple transmitters

The first contributors shall be the same as Rel-8/9 because the path-loss estimate algorithm and power control mechanism are identical as Rel-8/9. By considering the combination of the two contributors, the following table is proposed.

Table 6.2.5-1: P_{CMAX} tolerance in closed-loop spatial multiplexing scheme

P_{CMAX} (dBm)	Tolerance $T_{LOW}(P_{CMAX\_L})$ (dB)	Tolerance $T_{HIGH}(P_{CMAX\_H})$ (dB)
P_{CMAX} =23	3.0	2.0
[22] ≤ P_{CMAX} < [23]	[5.0]	[2.0]
[21] ≤ P_{CMAX} < [22]	[5.0]	[3.0]
[20] ≤ P_{CMAX} < [21]	[6.0]	[4.0]
[16] ≤ P_{CMAX} < [20]	[5.0]	
[11] ≤ P_{CMAX} < [16]	[6.0]	
[-40] ≤ P_{CMAX} < [11]	[7.0]	

6.3 Output power dynamics

Currently power control is defined on sub-frame basis for a single component carrier in REL8 in the RAN1 specification. For LTE-A, the architecture of single or multiple PA can have an impact on the power control dynamics. In the case where the PA supports a component carrier, the CM is not a concern since each component carrier will have a fixed maximum transmit power. But a single PA architecture can potentially impact the power control procedure when its power is shared amongst component carriers

Another consideration for study is whether the multi-CC UL signal is combined digitally (at the baseband) or in analogue (at IF or RF) since, the power control accuracy in terms accurate power control ratio amongst different CC will be less precise due to the analog component in the RF chain

For LTE-A power control would need to consider the following scenarios in the case of; OFF power, minimum power and power tolerance for CA, DLMA, ULMA and CPE

6.3.1 (Void)

6.3.2 Minimum output power

Requirements that need to be specified for the single and dual CC for the following:

1) CA_X (Intra band contiguous CA)

In Rel-8/9, the minimum controlled output power of the UE is defined as the broadband transmit power of the UE, i.e. the power in the channel bandwidth for all transmit bandwidth configurations (resource blocks), when the power is set to a minimum value. In the case of contiguous CA, the transmit power requirements could be defined following the approach adopted by DC-HSUPA, where the minimum transmit power for DC-HSUPA is defined as per-carrier and identical to the single carrier requirement. Given the similar RF architecture of single carrier and contiguous carrier aggregation, this requirement is expected to be feasible without significant change to current components and designs.

An excess minimum output power potentially increases Rise over Thermal (RoT). It would lead to the reduction of the cell coverage area for other UEs. To avoid it, the power density at the minimum output power from one UE should remain the same as that of Rel-8 as shown in Fig 6.3.2-1.

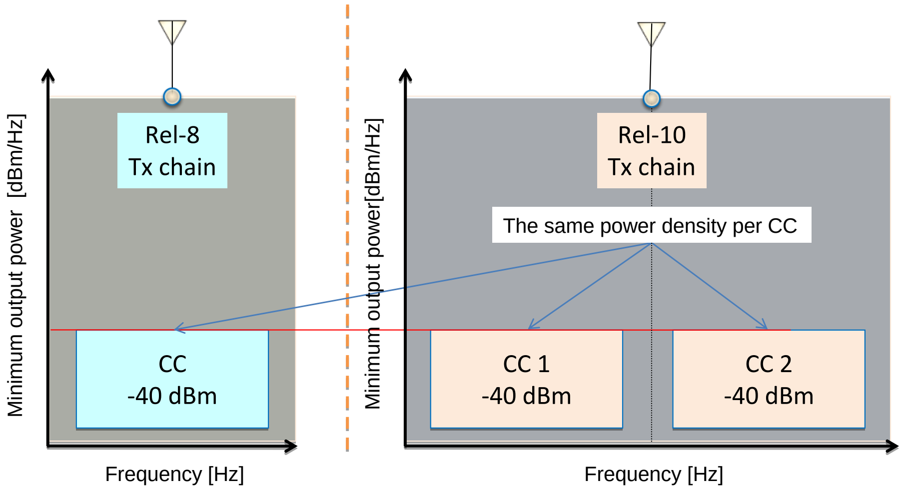


Figure 6.3.2-1: Minimum output power for intra band contiguous CA

It is proposed that the Minimum output power for intra-band contiguous CA: requirement per CC should remain the same as Rel-8 under the condition that the minimum power is transmitted on both CC. Note that these requirements are applied to the UEs with a single transmitter antenna.

2) CA_X-Y (Inter band non contiguous CA)

3) DLMA (Down link multiple antenna)

4) ULMA (Up link multiple antenna)

5) CPE (Customer Premises equipment)

6.3.3 Transmit OFF power

Requirements that need to be specified for the single and dual CC for the following:

1) CA_X (Intra band contiguous CA)

Transmit OFF power is defined as the mean power when the transmitter is OFF. The transmitter is considered to be OFF when the UE is not allowed to transmit or during periods when the UE is not transmitting a sub-frame. During measurements gaps, the UE is not considered to be OFF.

Compared to the minimum power requirements, this requirement is more critical since that ON/OFF time mask requirements are quite stringent for Rel-8/9. In addition, when one component carrier is in the transmit OFF state, the in-band emission from another component carrier could be larger than the OFF power requirements currently specified in Rel-8. On the other hand, if both carriers are OFF, the OFF power requirements could remain the same at each CC.

An excess transmit OFF power potentially increases Rise over Thermal (RoT). It would lead to the reduction of the cell coverage area for other UEs. To avoid it, the transmit OFF power density from one UE should remain the same as that of Rel-8 as shown in Fig 6.3.3-1.

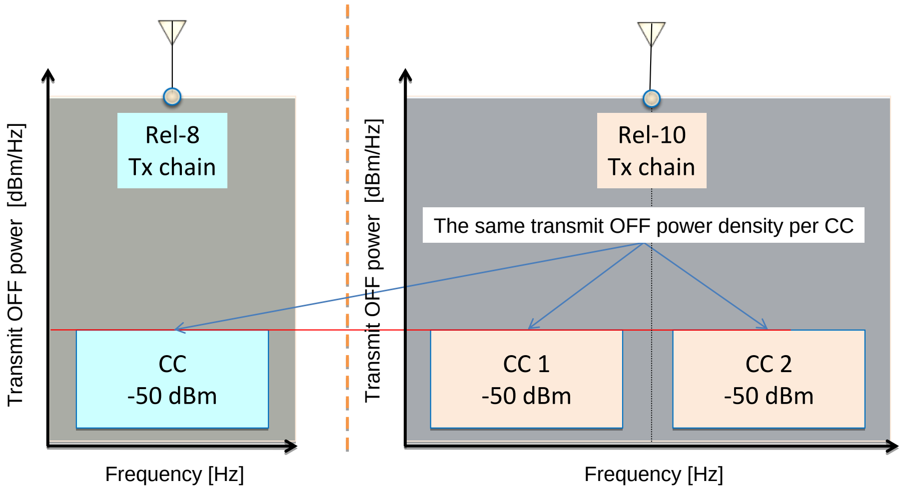


Figure 6.3.3-1: Transmit OFF power for intra band contiguous CA

In conclusion, the OFF power for intra-band contiguous CA: the requirement per CC should remain the same as Rel-8 under the condition that both CCs are OFF. Note that these requirements are applied to the UEs with a single transmitter antenna.

2) CA_X-Y (Inter band non contiguous CA)
3) DLMA (Down link multiple antenna)
4) ULMA (Up link multiple antenna)
5) CPE (Customer Premises equipment)

6.3.4 ON/OFF time mask

For LTE-A ON/OFF time mask would need to consider the following scenarios; Requirements that need to be specified for the single and dual CC for the following;

1) CA_X (Intra band contiguous CA)

For Intra band contiguous CA, when a single CC is transmitted Rel-8/Rel-9 requirements apply.

When two CCs are transmitted following conditions need to be considered:

For SRS transmitting in PCC and SCC, or PUCCH and PUSCH are transmitting separately in PCC and SCC, it is difficult to get the separate testing results for PCC and SCC and tell the two separate ramping figures when there is just one testing port. So define the ON/OFF time mask for each CC is not always feasible under the conditions.

For PRACH, there is only one Random Access procedure ongoing at any point in time. So for the PRACH time mask the requirements for single CC will always apply.

So when two CCs are transmitted the requirement of ON/OFF time mask need to be further investigated.

Further investigation:

The current time mask has 3 type of time period, i.e. OFF power period, transient period, and ON power period. For two carrier aggregation, there are 6 types of time period combinations. Every type of time period combination can lead to different requirement:

Time period combination		Requirements per CC		Requirements for UE
CC1	CC2	CC1	CC2	
OFF power period	OFF power period	OFF power	OFF power	OFF power
OFF power period	Transient period	No requirement	No requirement	No requirement
OFF power period	ON power period	CC2 out of band requirement on this CC	ON power	ON power
Transient period	Transient period	No requirement	No requirement	No requirement
Transient period	ON power period	No requirement	ON power	No requirement
ON power period	ON power period	ON power	ON power	ON power

For example, CC1 is scheduled PUCCH/PUSCH transmission at N+1 sub-frame after SRS at N sub-frame. CC2 is scheduled PUCCH/PUSCH transmission at N+1 sub-frame. The time mask requirements for each CC and UE are illustrated as Figure 6.3.4-1:

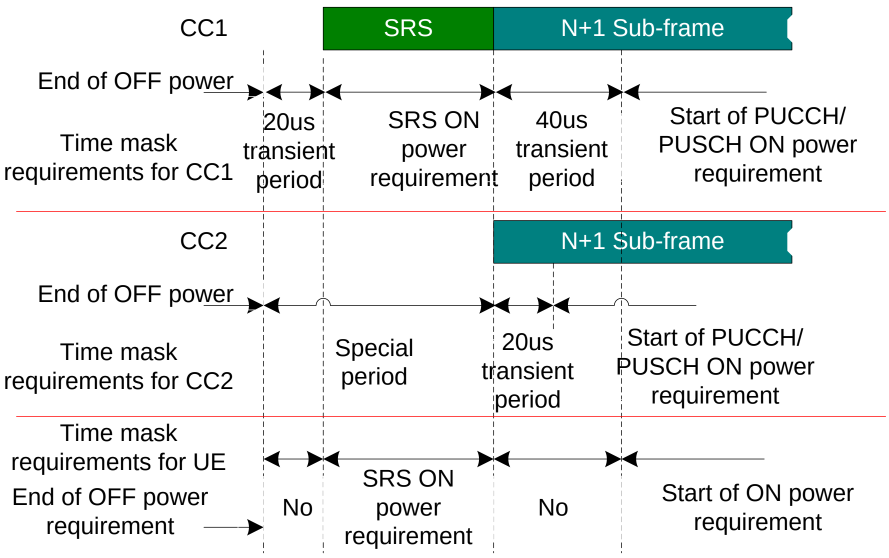


Figure 6.3.4-1: Time mask requirements for each CC and UE

In special period of CC2, the requirements of OFF power and ON power are not applied. In this period, UE should meet CC1 out of band emission on CC2 frequency range. On other time period, the time mask requirements for each CC is applied.

From above analysis for every time period combination, we can get that following conclusion: Current time mask requirements are applied for each CC during ON power period and transient period. The requirements for OFF power could only be applied for each CC during which both carriers are OFF simultaneously.

2) CA_X-Y (Inter band non contiguous CA)

The analysis for intra-band contiguous CA could also be applied.

3) DLMA (Down link multiple antenna)

4) ULMA (Up link multiple antenna)

The ON/OFF time mask defines the observation period between Transmit OFF and ON power and between Transmit ON and OFF power on the corresponding physical channels. The requirements for Transmit OFF power are specified at each transmit antenna, therefore, the ON/OFF time mask requirements reflecting the transient characteristics are specified for each transmit and the requirements shall be the same as Rel-8/9.

5) CPE (Customer Premises equipment)

6.3.5 Power Control

Currently power control is defined on sub-frame basis for a single component carrier in REL8 in the RAN1 specification. For LTE-A, the architecture of single or multiple PA can have an impact on the power control dynamics. Another consideration for study is whether the multi-CC UL signal is combined digitally (at the baseband) or in analogue (at IF or RF) since the power control accuracy in terms accurate power control ratio amongst different CC will be less precise due to the analog component in the RF chain . Requirements that need to be specified for the single and dual CC for the following:

1) CA_X (Intra band contiguous CA)
2) CA_X-Y (Inter band non contiguous CA)
3) DLMA (Down link multiple antenna)
4) ULMA (Up link multiple antenna)

UL power control requirements in Rel-8/Rel-9 are used to test the UE power setting accuracy. Three kinds of power tolerance are defined, including absolute power tolerance, relative power tolerance and aggregate power control tolerance. In Rel-10, with the assumption that most of the Rel-8/Rel-9 RF components would be reused in Rel-10, the power tolerance per antenna port would be the same as Rel-8/Rel-9.

UL PC for UL-MIMO has been discussed in RAN1 #62bis and RAN1 #63. In RAN1 #62bis, the following conclusions are drawn and agreed:

- No per antenna fast TPC commands - i.e. single TPC command
- Single path-loss estimation
- In case of k_s=0, power is divided between transmitting antennas in accordance with the ratio of the precoding weights (assuming no antenna gain imbalance compensation)

In RAN1 #63, *it is agreed that No Tx chain imbalance compensation is standardized in Rel-10.*

So for Rel-10, the power control algorithm is defined per UE without consideration on antenna gain imbalance. The transmit power per antenna port is the total transmit power per UE with ratio of precoding weights. Then the power control requirements should be defined per UE, similar as the requirements for maximum output power and MOP tolerance. That is, the power control requirements apply to the sum of power measured over each antenna port.

Since the power control requirements, including the absolute power tolerance, relative power tolerance and aggregate power control tolerance, apply to all the allowable transmit power. Considering the power tolerance per antenna port would be the same as Rel-8/Rel-9, with no Tx chain imbalance, the total power tolerance per UE would be the same as Rel-8/Rel-9 when the transmit power is equally divided among Tx chains for multiple antenna ports UE.

Table 6.3.5C shows the codebooks for multiple antenna ports mode with two antenna port. We can see the transmit power is equally divided among Tx chains except when the single-layer transmission with codebook index 4 or 5 is configured. In this case, the actual transmit power is the calculated transmit power minus 3 dB. The power tolerance should consider the possible additional 3 dB power step when move in or move out from other transmission mode to the single-layer transmission with codebook index 4 or 5.

Table 6.3.5C: Codebook for transmission on antenna ports $\{0,1\}$.

Codebook index	Number of layers $\upsilon=1$	Number of layers $\upsilon=2$
0	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\1\end{bmatrix}$	$\frac{1}{\sqrt{2}}\begin{bmatrix}1&0\\0&1\end{bmatrix}$
1	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\-1\end{bmatrix}$	-
2	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\j\end{bmatrix}$	-

3	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\-j\end{bmatrix}$	-
4	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\0\end{bmatrix}$	-
5	$\frac{1}{\sqrt{2}}\begin{bmatrix}0\\1\end{bmatrix}$	-

5) CPE (Customer Premises equipment)

6.4 Void

6.5 Transmit signal quality

Currently EVM performance is defined on slot bases for a single component carrier in REL8 in the RAN1 specification. For LTE-A EVM would need to consider the following scenarios; Requirements that need to be specified for the single and dual CC for the following;

Note the current RAN1 assumption assumes in the case of contiguous CC carriers then RB can be freely allocated for the different CC carriers

1) CA_X (Intra band contiguous CA)
2) CA_X-Y (Inter band non contiguous CA)
3) DLMA (Down link multiple antenna)
4) ULMA (Up link multiple antenna)
5) CPE (Customer Premises equipment)

6.5.1 Frequency error

- CA_X (Intra band contiguous CA)

  The UE modulated carrier frequency would be compared with the carrier frequency of the primary carrier received from Node B.

- CA_X-Y (Inter band non contiguous CA)

  For inter-band CA, the UE may have separate PLLs for each band. The frequency reference for each PLL would be from the corresponding DL CCs. The performance requirements shall be the same as Rel-8/9.

6.5.2 Transmit modulation quality

6.5.2.1 In-band emission for intra-band carrier aggregation

Non-contiguous uplink transmission different LO and image configurations (more exceptions) necessitate changes, but it could in fact be sufficient to test the in-band emissions in a Rel-8 fashion. We consider a number of cases.

6.5.2.1.1 In-band requirements and leakage from an unsynchronised adjacent carrier

First we consider the aspect is the leakage of the secondary carrier into the primary: this is normally governed by selectivity requirements like ACLR and ACS that must be met for each CC. This adjacent CC may belong to the own network or to an adjacent operator. The secondary CC will create additional uplink intra-cell interference in addition to that originating from multiplexed users. However, this case could already be a problem for Rel-8 operation since an adjacent operator would produce a similar type of interference.

Figure 6.5.2.1.1-1 shows the case of one operator using two activated uplink CC activated in the presence of an adjacent (interfering) operator on a single CC. A specification of the in-band emission could potentially cover the aggregated carriers with a possible LO component between the two carriers, the image component of a transmission on one of the CC will appear in the other CC. From a carrier leakage view point it may also be desirable to limit the emission into the adjacent CC, but one may have to rely on the present Rel-8 emission floor (up to 30 dB below the allocated PRB) in any case. The power of the interfering adjacent operator is uncoordinated and may be significantly higher than the wanted signal levels within the own network, particularly if site-sharing is not used. Hence the problem of leakage exists already for Rel-8 operation and one must rely on the provisions of the Rel-8 specifications like ACLR for co-existence. Specifying leakage between CC(s) within the same network in terms of in-band emission requirements would not add much under this scenario, and all CC(s) must meet the ACLR requirements anyway.

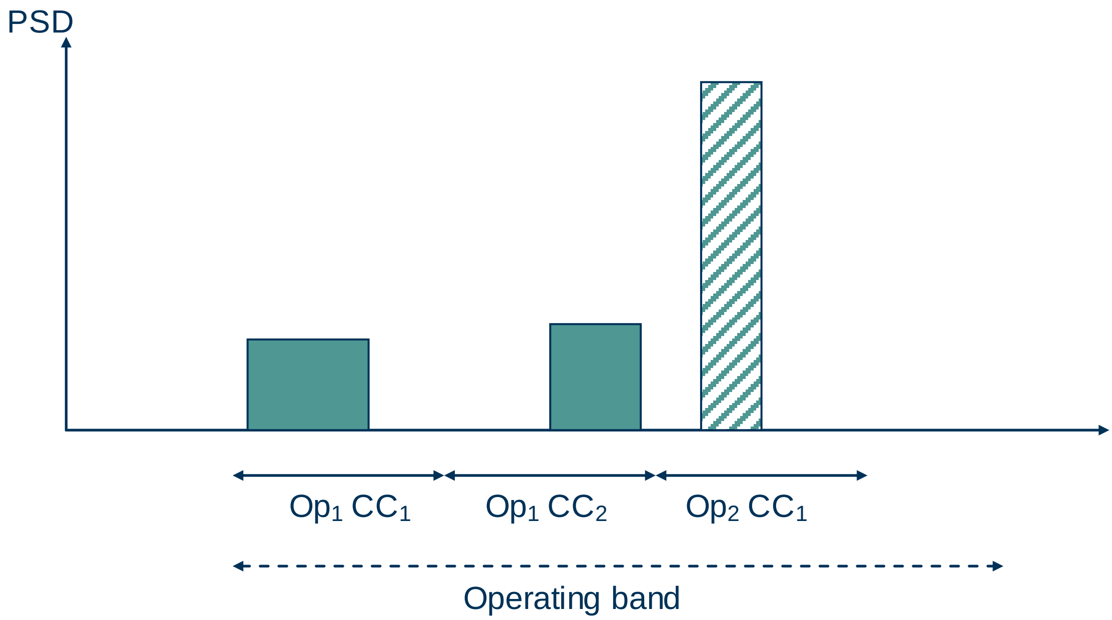


Figure 6.5.2.1.1-1: inter-operator interference scenario with CA.

Hence this suggests that the current in-band test is sufficient also for CA in view of the inter-operator interference scenario that is already present for Rel-8. The test would then be carried out separately for the primary and secondary CC with due account for the fact that the LO and image frequency positions may be different from the Rel-8 configuration when two UL CC(s) are configured, and architectures with more than one LO are not impossible.

6.5.2.1.2 In-band requirements for aggregated carriers within own network

The adjacent interference is not only added onto the wanted signal. Next we consider additional effects arising from the leakage or cross-talk between two CC generated within the same device, e.g. generated by one single transmitter chain through a single PA.

Even if the Rel-8 minimum performance requirements apply for the transmitter chain, the in-band requirements have to be modified if applied to two aggregated uplink CC in view of different LO and IQ image locations as explained above. The centre position between the CC is the most likely: the aggregation scenarios considered in Rel-10 are tailored to this case. Figure 6.5.2.1.2-1 shows a *very simplified* picture of the transmitter emissions for two aggregated carriers with the LO and image components shaded. Simultaneous PUSCH and PUCCH are also transmitted on the PCC to exemplify the effects. We remark that many more inter- and cross-modulation effects would appear for this multi-tone scenario. The in-band emissions are measured after the FFT which means that the impact of some of these latter effects will be reduced.

Should in-band emission requirements have to be specified for aggregated carriers (non-contiguous transmission), it appears reasonable to allocate RB in both component carriers in order to add to the existing single-carrier requirements. This would necessitate additional "exceptions" for

- possible LO locations
- locations for image products originating from the allocated PRB

- other inter-modulation products in view of non-contiguous transmission

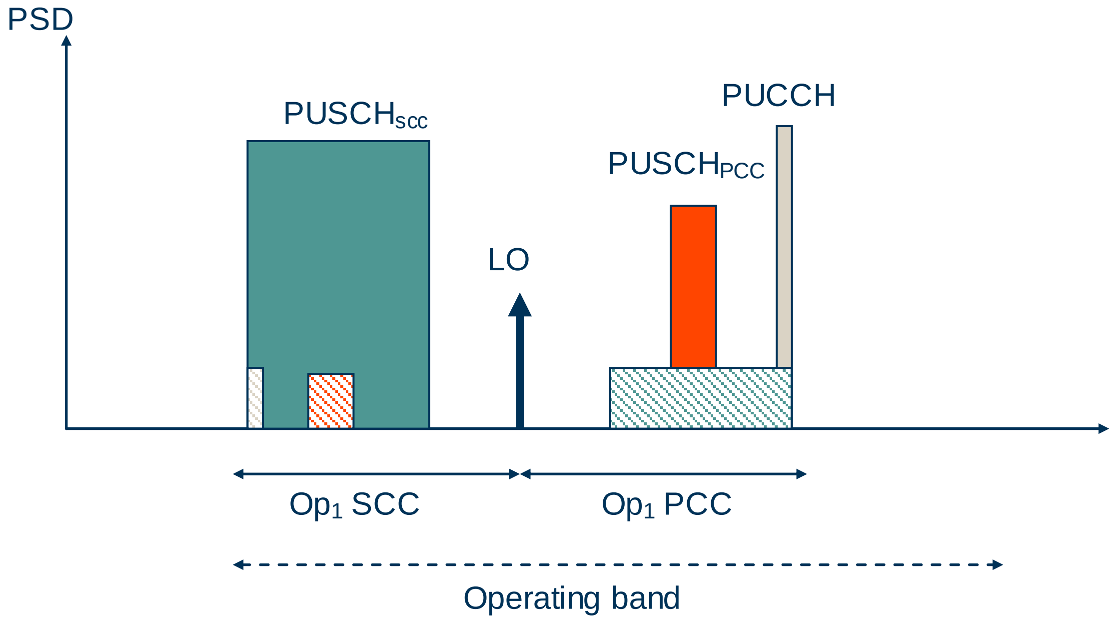


Figure 6.5.2.1.2-1: In-band emissions for transmission on two uplink CC(s)

The shape of the general in-band mask may have to be modified since cross-modulation products will appear around the allocated blocks, the magnitude of these depend on the relative powers of the allocated PRB(s). The requirements should be general and apply for any combinations of PRB sizes of the allocated blocks. Specifying in-band emission requirement for clustered PUSCH or simultaneous PUSCH and PUCCH will obviously necessitate multiple PRB allocations on a single CC. Is such a test needed from a functionality, user- and system performance standpoint?

If the SCC is deactivated and no simultaneous PUSCH and PUCCH on the PCC, the scenario is similar to Rel-8 operation but the locations of the LO and image are different, these are depicted in grey and black in Figure 6.5.2.1.2-2. The magnitude of these responses would still be dictated by the Rel-8 transmitter requirements. Similarly, if no simultaneous transmission is allowed from a single UE (as in Figure 6.5.2.1.2-2), neither on a CC nor across two active CC, the interference scenario would be similar to the Rel-8 case but with the image responses smeared out across two CC(s). Here we neglect effect of e.g. the independent power control on the two uplink CC(s) that may give rise to differences in practice.

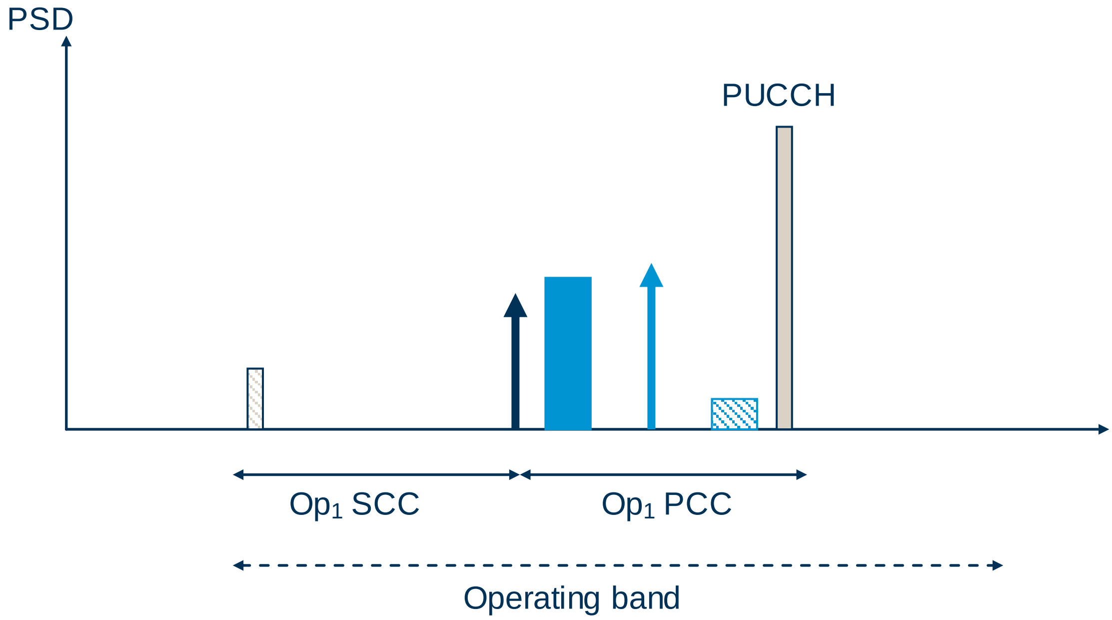


Figure 6.5.2.1.2-2: in-band emissions for a UE with a single PRB allocation and the SCC deactivated (grey), and a UE in fall-back mode (blue)

The UE could also fall-back to Rel-8 operation, which would generate the responses in blue in Figure 6.5.2.1.2-2 for a single PUSCH. The in-band emission requirements for Rel-8 must then be satisfied to ensure coexistence with legacy devices.

From a functionality viewpoint, it should be sufficient to verify a Rel-10 UE supporting two UL CC(s) by using the existing in-band test case with a single UL CC configured. This would also cover coexistence with legacy UE(s).

From a user- and system performance standpoint, the specification if in-band emissions per CC would not reveal all effects on the in-band emission floor of simultaneous transmission from a single UE. The following two scenarios,

- transmission of a PUSCH and a PUSCH/PUSCH, both contiguous, on two separate CC(s) compared to the case in which these two transmissions originate from two separate UE(s) located on the PCC and SCC, respectively,
- clustered DFT-SOFDM and/or simultaneous PUSCH and PUSCH transmissions from one UE across two CC(s) compared to the case in which these transmissions originate from multiple sources, could provide some insight on a link level. However, the necessity to verify the in-band performance is not as obvious as the verification of the unwanted emissions outside the allocated operator block.

6.5.2.2 Error Vector Magnitude

For the intra-band contiguous CA, the Error Vector Magnitude requirement should be defined for each CC.

When a single CC is transmitted Rel-8 EVM requirements apply.

When two CCs are transmitted with the same PSD the EVM requirements apply for each CC. The requirements are according to Table 6.5.2.2-1. The EVM requirements for carriers transmitted with different PSD are FFS.

Table 6.5.2.2-1: Minimum requirements for Error Vector Magnitude

Parameter	Unit	Average EVM Level per CC	Reference Signal EVM Level
QPSK or BPSK	%	[17.5]	[17.5]
16QAM	%	[12.5]	[12.5]

6.6 Output RF spectrum emissions

Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emissions, intermodulation products and frequency conversion products, but exclude out of band emissions.

As captured in TR36.803 the spectrum emission mask scales in proportion to the channel bandwidth due to PA non-linearity for a single component carrier. In the case of multiple contiguous CC scenarios should the spectrum mask be proportional to the total number of contiguous channel bandwidth (REL8 approach) or be unchanged and be no different from that of a single CC bandwidth?

R4-102739: Way forward

1. Adopt the 40 MHz SEM agreed in RAN4 #52 (R4-093151) for 100+100 RB CA transmission bandwidth configuration noting that NS_x approach can be used to meet additional regional requirements.

2. SEM requirement is defined per carrier aggregation bandwidth class.

6.6B Output RF spectrum emissions

The UE transmission power is controlled by the power control mechanism specified in TS36.213, and the same power control algorithm is applied to control the total UE transmission power for single-antenna connector transmission and multi-antenna connector transmission. The same maximum output power per UE is applied to both single-antenna connector transmission and multi-antenna connector transmission, and the UE total transmission power is always being controlled to be below the UE total maximum output power.

LTE Advanced coexistence study has been conducted and the results are captured in Chapter 12 in TR36.942 (Rel-10), "LTE Advance Coexistence". For UE with multiple transmit antenna, the coexistence study results shall be the same, if same ACIR model is applied to the same total maximum output power for UE.

The average transmission power per antenna connector in 2 TX UL MIMO transmission is reduced by 3 dB comparing with that of single antenna connector transmission per UE. Therefore, the average unwanted emissions per antenna would be basically reduced by 3 dB as well. As a result, the total amount of unwanted emission of multi-antenna connector transmission per UE would be the same as that of single-antenna connector transmission per UE. Consequently, the impact of total amount of unwanted emissions from a Release 10 UE with UL-MIMO supported would be the same as a Release 8 UE in terms of co-existence with legacy systems in the adjacent bands.

It is concluded that even when the "per antenna connector" approach is adopted in the specifications, the total amount of unwanted emissions of a Release 10 UE supporting UL-MIMO would be the same as that of a Release 8 UE in real network if the same power control mechanism and the same total maximum transmission power are applied. Therefore, there would be no co-existence issue with other legacy systems in the adjacent bands even when the unwanted emission requirements are defined as "Release 8/9 requirements per antenna connector" which is also in line with the regulatory recommendation in ITU-R SM.329.

In summary, the requirements for UE with two transmit antenna connectors are "to apply the Rel.-8/9 unwanted emission requirements at each antenna connector".

6.6.1 Occupied bandwidth

In some regions the concept of "Occupied bandwidth" is used in current regulation to define the value of "Necessary bandwidth" (N.B.). N.B. may be used in radio regulation as a parameter to separate the spurious domain from the out-of-band domain.

As it is expected that "Occupied bandwidth" may be adopted as a regulatory requirement in some regions also for contiguously aggregated CCs, it is proposed to define in TS 36.101 an OBW requirement specifically for contiguous CA.

Occupied bandwidth can be derived from the UE Aggregated Channel Bandwidth, $BW_{Channel\_CA}$, (see Clause 5.6), as follows:

$$\text{Occupied bandwidth} \leq BW_{Channel\_CA} \text{ [MHz]},$$

in which the carrier spacing between component carriers shall be in accordance with the nominal channel spacing defined for contiguously aggregated component carriers in Clause 5.7.1.

The carrier spacing between component carriers is assumed as the nominal channel spacing in order to obtain a well-defined, single requirement for the UE equipment.

6.6.2 Out of band emission

6.6.2.1 Spectrum emission mask

Note the current RAN1 assumption assumes in the case of contiguous CC carriers then RB can be freely allocated for the different CC carriers

6.6.2.2 Additional Spectrum Emission Mask

Note the current RAN1 assumption assumes in the case of contiguous CC carriers then RB can be freely allocated for the different CC carriers

6.6.2.3 Adjacent Channel Leakage Ratio

Depending on the adjacent channel bandwidth (single or multiple CC) it may be necessary to investigate the impact of ALCR with different number of CC for the following;

1) CA_X (Intra band contiguous CA)

R4-102739; Way forward:

Adopt REL-8/9 ACLR requirements for REL-10 carrier aggregation

$UTRA_{ACLR1}$ = 33 dBc

$UTRA_{ACLR2}$ = 36 dBc

In this chapter we present the results of a study were it was investigated which of the ACLR requirement is dimensioning for aggregated signal which consists of two component carriers. This study was not limited to those CC combinations that are applicable for REL-10 instead all possible combinations of REL-8 channel bandwidth were studied. Figure 6.6.2.3-1 below illustrates the agreed ACLR requirements for REL-10.

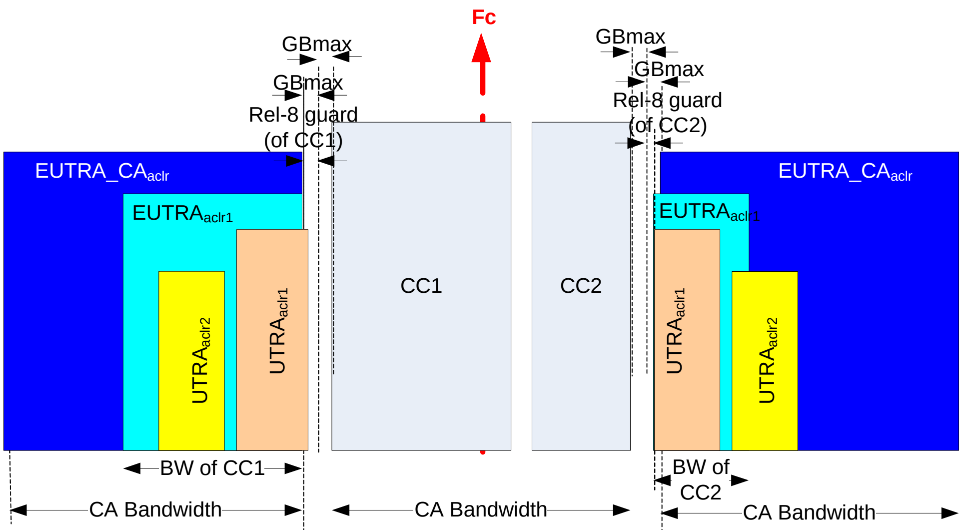


Figure 6.6.2.3-1: REL-10 ACLR requirements

From the above figure, the following points can be noticed.

1) The guard bands around the aggregated signal are the maximum of the two release-8 component carriers, GB_{max}

2) $EUTRA_{aclr1}$ is simulated as defined in chapter 6.6.2.3.1A in [2].

3) $UTRA_{aclr1}$ and $UTRA_{aclr2}$ are simulated as defined in chapter 6.6.2.3.2A in [2].

4) The $EUTRA\_CA_{aclr}$ is simulated as defined in chapter 6.6.2.3.3A in [2].

5) It is evident from Figure 6.6.2.3-1 that the $EUTRA_{aclr1}$ on the left and right side of the CA signal would be different if the bandwidths of CC1 and CC2 are different. Hence, the over all $EUTRA_{aclr1}$ of the Rel-10 signal is defined as the minimum of the $EUTRA_{aclr1}$ on the left and right side.

6) It is further noted that for a fully populated asymmetric configuration, the $EUTRA_{aclr1}$ measurements will typically be highest adjacent to the higher bandwidth carrier.

In addition to agreed ACLR requirements also $EUTRA_{aclr2}$ behaviour versus agreed ACLR requirements were studied because it has been discussed in RAN4. There is no intention to specify this requirement but the results are presented for information. Figure 6.6.2.1-2 illustrates how EUTRAaclr2 is defined.

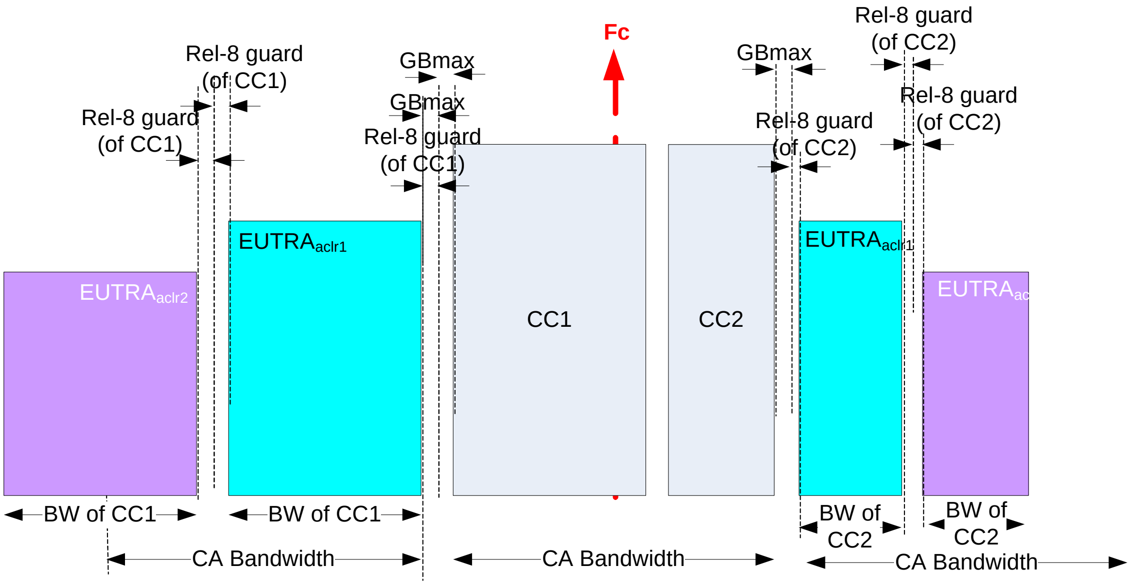


Figure 6.6.2.3-2: E-UTRA$_{ACLR2}$ definition

Simulation procedure and assumptions

First the operating point for the Rel-10 waveform as shown in 6.6.2.3-1 is determined by adjusting the required backoff of the PA such way that the worst of $UTRA_{aclr1} \geq 33$ dB, $UTRA_{aclr2} \geq 36$ dB and $E\text{-}UTRA_{aclr} \geq 30$, $E\text{-}UTRA\_CA_{aclr} \geq 30$ dB is just satisfied.

Secondly, the various other ACLR results are recorded at this operating point. This process is repeated for all combinations of bandwidths of CC1 and CC2.

For the simulations the following RF parameters are used.

Table 6.6.2.3-1: RF parameters

Parameter	Value
Carrier suppression	25 dB
Image suppression	25 dB
Counter IM 3 suppression	60 dB
Number of subframes per simulation point	4

Results

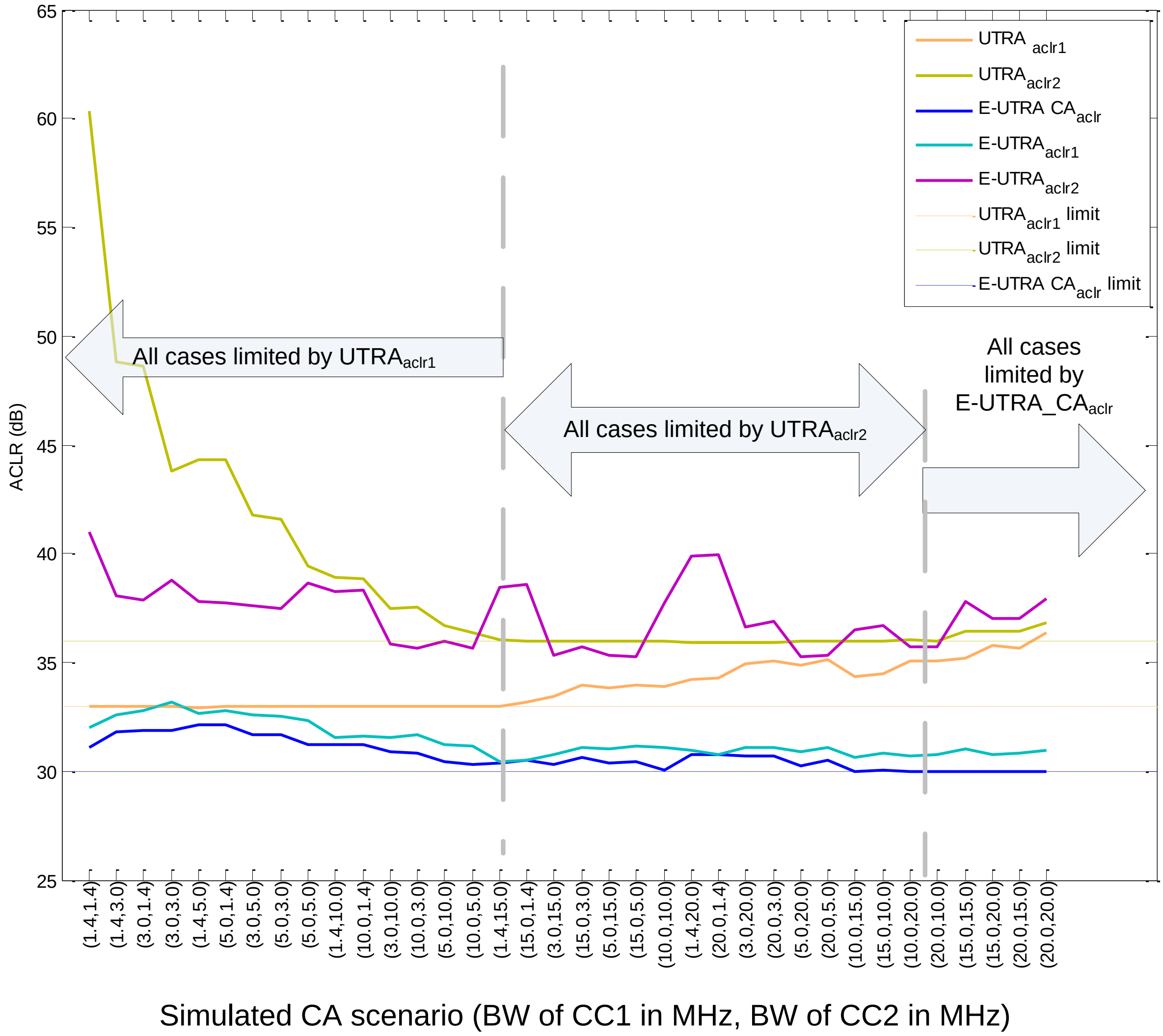


Figure 6.6.2.3-3: Simulation results

Figure 6.6.2.3-3 above shows the simulation results. Limit lines are provided for the four limiting ACLR metrics used to define the modulator operating point. The graph is divided into three regions corresponding to the limiting metric.

It should be noted that the scenarios depicted on the far left of the figure do not represent likely deployment scenarios, but they are included for completeness.

This study showed the results of simulated ACLR values for EUTRA waveform consisting of two component carriers. It is showed that for the channel arrangement parameters agreed for REL-10 the $EUTRA\_CA_{aclr}$ is the limiting ACLR metric for CA bandwidth Class C.

1) CA_X-Y (Inter band non contiguous CA)

2) DLMA (Down link multiple antenna)

3) ULMA (Up link multiple antenna)

4) CPE (Customer Premises equipment)

6.6.2.4 Additional ACLR requirements

6.6.3 Spurious emissions

Table 6.6.3-1 is the guideline regarding spurious domain cited from ITU-R SM.1541:

Table 6.6.3-1: Start and end of OOB domain

Type of emission	If necessary bandwidth B_N is:	Offset (±) from the centre of the necessary bandwidth for the start of the OoB domain	Frequency separation between the centre frequency and the spurious boundary
Narrow-band	< B_L (see Note 1)	0.5 B_N	2.5 B_L
Normal	B_L to B_U	0.5 B_N	2.5 B_N
Wideband	> B_U	0.5 B_N	B_U + (1.5 B_N)

NOTE 1 – When $B_N < B_L$, no attenuation of unwanted emissions is recommended at frequency separations between 0.5 B_N to 0.5 B_L.

NOTE 2 – B_L and B_U are given in Recommendation ITU-R SM.1539.

The offsets in table 6.6.3-1 above are from the centre carrier frequency. Following the equation defined for wideband in the table 6.6.3-1 above, and by assigning B_U to be 5 MHz, the spurious domain boundary for LTE Rel-8 channel bandwidth is defined as Table 7.9-2 where Δf_{OOB} is the offset of frequency range from channel edge for single carrier:

Table 6.6.3-2: Boundary between E-UTRA Δf_{OOB} and spurious emission domain

Channel bandwidth	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Δf_{OOB} (MHz)	2.8	6	10	15	20	25

In SM.1541, the spurious domain for multiple carrier emission is defined to start from the edge of the assigned bandwidth. The guideline in SM.1539 and SM.1541 can be followed to define the spurious domain for LTE-A UE supporting intra-band contiguous CA. Therefore, the boundary of spurious domain, or Δf_{OOB}, which is the offset from CA channel edge can be calculated by the formula below:

$$\Delta f_{OOB} = B_U + (1.5\ B_N) = \text{CA channel bandwidth} + 5\text{MHz}$$

It is recommended that the strict Category B requirements for spurious domain emission as defined in ITU-R SM.329 [4] is followed for LTE-A UE supporting CA in the CA spurious domain to allow global roaming and UE coexistence.

Table 6.6.3-3: Spurious emissions limits

Frequency Range	Maximum Level	Measurement Bandwidth
9 kHz ≤ f < 150 kHz	-36 dBm	1 kHz
150 kHz ≤ f < 30 MHz	-36 dBm	10 kHz
30 MHz ≤ f < 1000 MHz	-36 dBm	100 kHz
1 GHz ≤ f < 12.75 GHz	-30 dBm	1 MHz

It's for FFS whether the requirements in Table 6.6.3-3 could be band specific.

6.6.3.1 Minimum requirements

6.6.3.2 Spurious emission band UE co-existence

One aspect relating to the emission spectrum would be UE to UE co-existence. In this case the following aspects would need FFS;

- *UE1 (Tx) and U2 (Rx) configuration for UE to UE co-existence analysis*
- *Should the same limit (-50 dBm /1 MHz) be applicable*
- *In the case of inter band scenario how do we address harmonic requirements*
- *TDD non synchronized operation*

Note the current RAN1 assumption assumes in the case of contiguous CC carriers then RB can be freely allocated for the different CC carriers

1) CA_X (Intra band contiguous CA)
2) CA_X-Y (Inter band non contiguous CA)
3) DLMA (Down link multiple antenna)
4) ULMA (Up link multiple antenna)
5) CPE (Customer Premises equipment)

6.6.3.3 Additional spurious emissions

6.7 Transmit intermodulation

The transmit intermodulation performance is a measure of the capability of the transmitter to inhibit the generation of signals in its non linear elements caused by presence of the wanted signal and an interfering signal reaching the transmitter via the antenna.

Note the current RAN1 assumption assumes in the case of contiguous CC carriers then RB can be freely allocated for the different CC carriers

1) CA_X (Intra band contiguous CA)

User Equipment(s) transmitting in close vicinity of each other can produce intermodulation products, which can fall into the UE, or eNode B receive band as an unwanted interfering signal. The UE intermodulation attenuation is defined by the ratio of the mean power of the wanted signal to the mean power of the intermodulation product on both component carriers when an interfering CW signal is added at a level below the wanted signal at each of the transmitter antenna port with the other antenna port(s) if any is terminated.

We know that Transmitter intermodulation requirements for UMTS UE are specified in conjunction with ACLR requirements. Namely Tx intermodulation level measured in the interested adjacent channel is not masked by the contribution of the ACLR. In UMTS case, the intermodulation requirements can be estimated through ACLR requirement and inherent Tx intermodulation,which can be shown by the following equation:

$$\text{Intermodulation requirement}=10\lg\left(10^{ACLR/10}+10^{-\text{inherent TX IM}/10}\right)$$

For example, for 20 MHz in LTE R8/9, the ACLR requirement is $ACLR_1$=-30 dBc , $ACLR_2$=-36 dBc, and in case inherent Tx intermodulation of -35 dBc (with interferer CW at 20 MHz offset) and -45 dBc (with interferer CW at 40 MHz offset) are assumed, the following intermodulation level (Tx IM [measured]) would be applied.

ACLR	-30	-36	dBc
Tx IM [inherent]	-35	-45	dBc
Tx IM [measured]	-29	-35	dBc

For the intra-band contiguous CA, the ACLR requirement has been defined as CA E-$UTRA_{ACLR}$= -30 dBc, though the second ACLR for CA is not defined now, but we can assumed that the second ACLR=36 dBc for keeping the consistency with R8/9, so we can get that the intermodualtion product requirement will the same with R8/9.

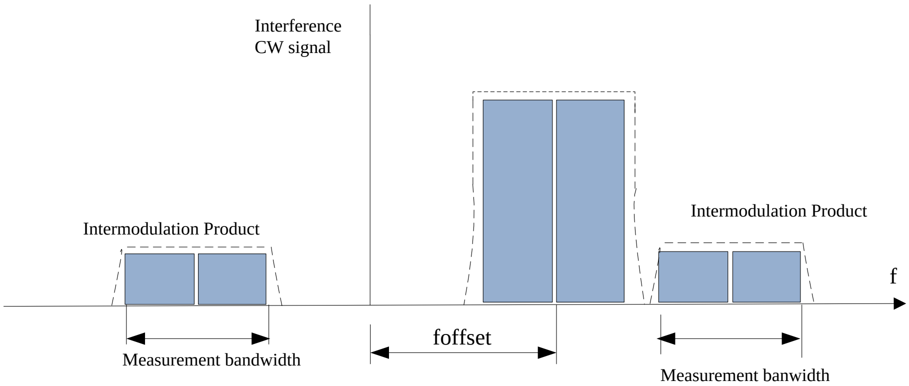


Figure 6.7-1: the PSD distribution of transmit intermodulation for intra-band contiguous CA

The PSD distribution of transmit intermodulation for intra-band contiguous CA was show in fig1, we propose that the Interference Signal Frequency Offset are $BW_{Channel\_CA}$ and 2* $BW_{Channel\_CA}$, and the measurement bandwidth is $BW_{Channel\_CA}$- 2* BW_{GB}.

2) CA_X-Y (Inter band non contiguous CA)

3) DLMA (Down link multiple antenna)

4) ULMA (Up link multiple antenna)

5) CPE (Customer Premises equipment)

6.8 Time alignment between transmitter branches for UL-MIMO

For UE(s) with multiple transmit antenna(s)/antenna connectors(s) supporting closed-loop spatial multiplexing transmissions, the requirements for Time Alignment Error (TAE) specify the maximum allowed time difference between the signals from multiple transmit antenna(s)/antenna connectors(s). Two factors are considered when specifying the time alignment requirements:

- Performance impact: Time alignment error between different transmit branches compromises the demodulation performance which eventually leading to throughput loss.

- Implementation consideration: Un-necessary tighter requirements on the time alignment error impose additional cost to control the time differences introduced by different components.

Based on the evaluation of performance loss due to TAE, it's proposed to tentatively set the TAE requirements to be [130ns] for UE with two transmit antennas.

7 Receiver characteristics

7.1 General

Rx characteristic are specified for the following scenarios:

1) CA_X (Intra band contiguous CA)

2) CA_X-Y (Inter band non contiguous CA)

3) DLMA (Down link multiple antenna)

4) ULMA (Up link multiple antenna)

UE supporting closed-loop spatial multiplexing scheme may be equipped with multiple transmit antennas/antenna connector(s). For UE(s) with an integral antenna only, a reference antenna(s) with a gain of 0 dBi is assumed for each antenna port(s). The UE antenna performance has a significant impact on system performance, and the minimum requirements with antenna performance considered are therefore FFS.

Unless otherwise stated the receiver characteristics are specified at the antenna connector(s) of the UE. For UE in Single-Antenna Port Scheme before eNodeB is aware of the UE transmit antenna configuration, Rel-8/9 requirements shall be met by default. The requirements for Single-Antenna Port Scheme are implementation agnostic.

UE receiver requirements with two receiver antenna connectors and two transmit antenna connectors shall be considered in Rel-10 time frame. The receiver requirements with more than two transmit and/or two receiver antennas are FFS.

5) CPE (Customer Premises equipment)

Table 7-1 illustrates various Rx architectures options

Table 5.3.3-1: Possible UE Architecture for the three aggregation scenarios

Rx Characteristics				
Option	Description (Rx architecture)	Intra Band aggregation		Inter Band aggregation
		Contiguous (CC)	Non contiguous (CC)	Non contiguous (CC)
A	Single (RF + FFT + baseband) with BW>20MHz	Yes	-	
B	Multiple (RF + FFT + baseband) with BW≤20MHz	Yes	FFS	Yes

Type A: As per TR36.815 can support; CA_X, CA_X-Y, DLMA, and CPE depending on UE capability

Type B: As per TR36.815 for FFS

Type C: As per TR36.815 for FFS

Type D: As per TR36.815 can support; CA_X, CA_X-Y, C DLMA, ULMA and CPE depending on UE capability

7.2 Diversity characteristics

7.3 Reference sensitivity power level

The current reference sensitivity power level REFSENS is the minimum mean power applied to both the UE antenna ports at which the throughput shall meet or exceed the requirements for the specified reference measurement channel

For LTE-A

- *Should this be applicable to all ports*
- *Sensitivity defined per single CC or multiple CC.*

Requirement that need to be specified for the single and dual CC for the following;

1) CA_X (Intra band contiguous CA)
2) CA_X-Y (Inter band non contiguous CA)
3) DLMA (Down link multiple antenna)
4) ULMA (Up link multiple antenna)
5) CPE (Customer Premises equipment

The REFSENS requirement for carrier aggregation is defined in following manner.

1. One additional REFSENS test for intra-band CA and the UL allocation depends on UL-DL separation.
2. Txpower is Pumax for both cases.
3. The SCC is in same position always.
4. Equal PSD for PCC and SCC
5. No MSD requirement

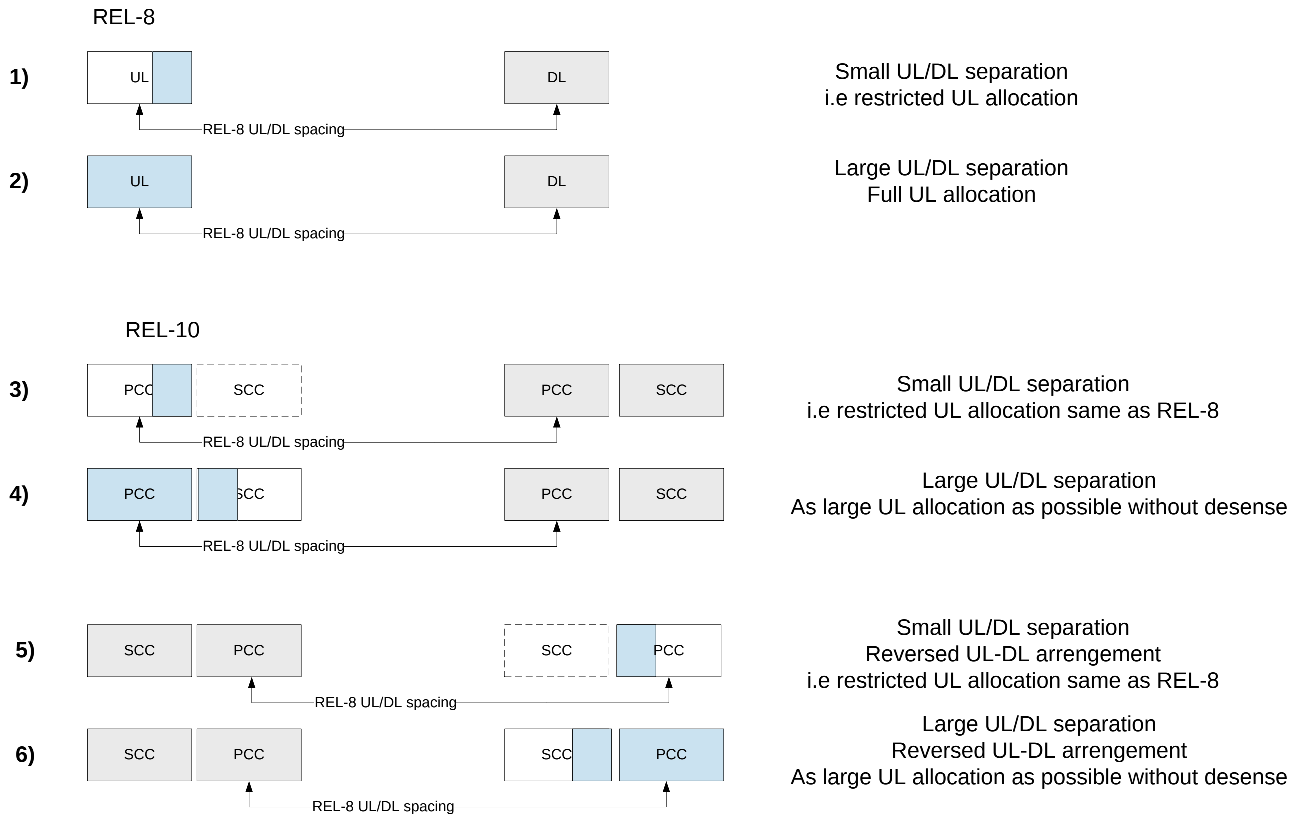


Table 7.3-1 specifies the maximum number of allocated uplink resource blocks for which the intra-band CA reference receive sensitivity requirement must be met. . The PCC allocation follows Table 7.3.1-2 in 36.101 Rel-9. SCC and PCC transmission forms a contiguous allocation.

PCC and SCC TX–RX frequency separations follow the specification in Subclause 5.7.4 for carrier aggregation.

Table 7.3-1: Intra-band CA uplink configuration for reference sensitivity

CA Band / Aggregated channel bandwidth / NRB / Duplex mode							
CA Band	**20MHz+15MHz**		**15MHz+15MHz**		**20MHz+20MHz**		**Duplex Mode**
CA_1C	n/a	n/a	PCC	SCC	PCC	SCC	FDD
	n/a	n/a	75	TBD	100	TBD	
CA_40C	PCC	SCC	PCC	SCC	PCC	SCC	TDD
	100	50	75	75	100	100	
NOTE: 1. The carrier centre frequency of SCC in the UL operating band is configured closer to DL operating band. 2. The transmitted power over both PCC and SCC shall be set to P_{UMAX} as defined in clause 6.2.5. 3. The UL resource blocks in both PCC and SCC shall be confined within the transmission bandwidth configuration for the channel bandwidth (Table 5.6-1).							

7.3.2 Requirement for large transmission configurations

Should the TX be specified for REFENSE be should be single RB, full allocation (single or multiple CC)?

Requirement that need to be specified for the single and dual CC for the following;

1) CA_X (Intra band contiguous CA)

2) CA_X-Y (Inter band non contiguous CA)

3) DLMA (Down link multiple antenna)

4) ULMA (Up link multiple antenna)

For UL-MIMO with dual transmitters and dual receivers, the Rel-8/9 Refsens level requirements shall apply for dual-layer transmission.

5) CPE (Customer Premises equipment)

7.4 Maximum input level

1) CA_X (Intra band contiguous CA)

One of the limiting factors for maximum input level is the dynamic range of UE RFFE. For single carrier UEs, the requirement of maximum input level of -25 dBm is tested with only one radiating eNB within the frequency band. In both single carrier and contiguous bandwidth carrier aggregation UEs, the front end (LNA, AGC and mixer) is directly exposed to the duplexer pass band before the Rx chain narrows down to the actual channel bandwidth. Hence, the receiver performance would be impacted by the total power received over the operating band for both single CC and CA UEs. In practice, a single carrier UE performance is expected to degrade if neighboring frequencies are also loaded since the RFFE will receive more than -25 dBm in the band of interest for the same near base station coverage.

Two alternative proposals have been evaluated for intra-band contiguous carrier aggregation maximum input level:

- ***Proposal 1***: Maintain -25 dBm requirement, change the definition

  "This is defined as the maximum mean power received at the UE antenna port, at which the specified relative throughput shall meet or exceed the minimum requirements for the specified reference measurement channel."

  to read as

  "This is defined as the maximum mean power received at the UE antenna port per component carrier, at which the specified relative throughput shall meet or exceed the minimum requirements for the specified reference measurement channel."

- ***Proposal 2***: no change to current definition, i.e., the maximum input level is defined as the total received power at the UE antenna port.

For intra-band contiguous carrier aggregation, each aggregated channel contains multiple Rel9 channels. In this case, if each component carrier is received at -25 dBm as in proposal 1, the LNA would receive a total of -22 dBm. If the performance requirement remains the same as for Rel-9 single carrier UE, this effectively mandates 3 dB improvement in LNA dynamic range, which requires further feasibility studies.

In order to understand the network side impact of maximum input level requirements, let us consider a dual-carrier Rel-10 network with mixed Rel-8/9/10 single carrier UEs and Rel-10 carrier aggregation UEs. The single carrier UEs are expected to have 3 dB increased MCL to the base station in this dual-carrier deployment compared to that of an isolated single carrier deployment. Requiring carrier aggregation UEs to maintain -25 dBm maximum input level per CC effectively tightened the coverage requirements for carrier aggregation UEs compared to single carrier UEs. As we know, the main design goal of carrier aggregation is to improve the UE peak rate and trunking capability. Increasing near base station coverage for carrier aggregation UEs relative to single CC UEs does not seem to be an essential feature. Note that single CC Rel-10 UEs with eDL-MIMO and UL-MIMO will still have the same maximum input level performance as in Rel-8/9.

Based on the discussion above, it is reasonable to adopt proposal 2, i.e., maintain the Rel-9 definition of maximum input level at the antenna port for carrier aggregation UEs. This would allow a consistent near base station coverage for all UEs.

Proposal A: maintain the same definition of maximum input level for intra-band carrier aggregation.

On the other hand, further studies might be required to verify potential improvements in LTE UE FE dynamic range. In principle it should not be expected that the maximum input level at the antenna port could increase with the # of component carriers. In the case of DC-HDSPA, a maximum input level of -22 dBm is defined for a dual-carrier 10 MHz receiver at both 16QAM and 64QAM set points [3]. However, further studies are required to validate whether such an input level is feasible for a wider band system such as CA_1C and CA_40C at 40 MHz bandwidth. We suggest to leave this requirement as [-25 dBm] as in Rel-8/9 for the time being. The group should evaluate the receiver performance at -22 dBm and revisit the requirements in the future.

Proposal B: Leave the maximum input level is at [-25 dBm].

2) CA_X-Y (Inter band non contiguous CA)

3) DLMA (Down link multiple antenna)

4) ULMA (Up link multiple antenna)

The maximum input level is defined as the maximum mean power received at the UE antenna port, at which the specified relative throughput shall meet. And the purpose of this test is to verify the dynamic range of a UE front end (including LNA, AGC and mixer). For Rel-8/9 UE, the maximum input level of -25 dBm is calculated by the following formula:

Maximum input level = eNB Tx power – MCL – Body loss,

in which eNB Tx power is assumed to be 46 dBm, MCL between UE to eNB is 70 dB and the body loss is 1 dB.

For UL-MIMO with dual transmitters and dual receivers, the maximum input level at the UE receiver antenna port should keep the same as Rel-8/9 requirement and shall be met for dual-layer transmission.

5) CPE (Customer Premises equipment)

7.5 Adjacent Channel Selectivity (ACS)

ACS is the ratio of the receive filter attenuation on the assigned channel frequency to the receive filter attenuation on the adjacent channel(s). Requirement that need to be specified for the single and dual CC for the following;

1) CA_X (Intra band contiguous CA)

The REFSENS for intra-band contiguous carrier aggregation is determined by each CC meeting the requirements in R8/9. It means no total REFSENS for intra-band contiguous carrier aggregation, so we propose that when we test ACS for intra-band contiguous, the PCC and SCC downlinks are both activated, but each is tested individually with its respective interferer, and the interferer frequency offset refers to the center frequency of the adjacent CC being tested. The PSD distribution diagram about ACS test for intra-band contiguous CA is shown as follow.

So, when we test ACS for intra-band contiguous CA, the PCC and SCC downlinks are both activated, and each is tested individually with its respective interferer.

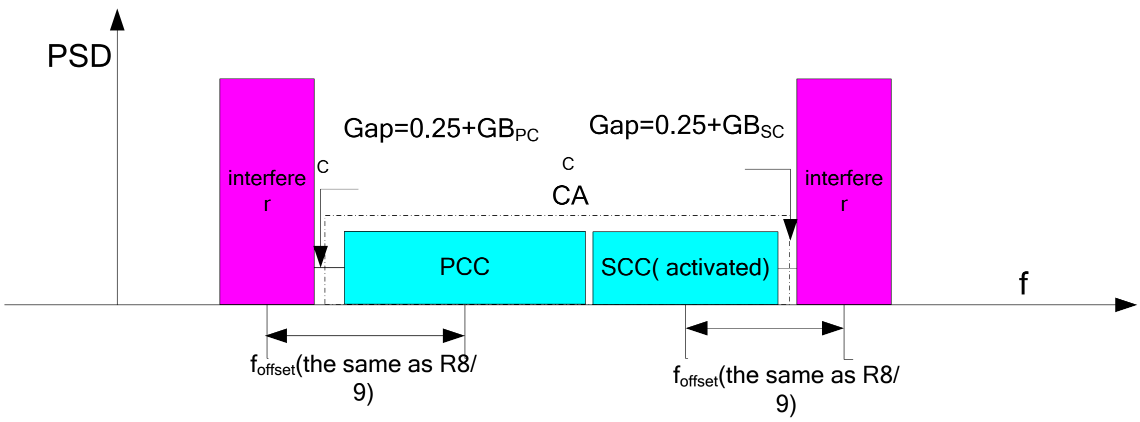


Figure 7.5-1: The PSD distribution diagram about ACS test for intra-band contiguous CA with a 5 MHz interferer

For Rel-8, the minimum requirement of the ACS is 27 dB for the 20 MHz channel bandwidth with its 1 MHz guard. For Rel-10 and CA Class C, the maximum aggregated bandwidth is 39.8 MHz also with a 1 MHz symmetric guard. We propose a *tentative* ACS_CA for the aggregated carriers in the following including effects of cross-modulation. ACS_CA is the ratio of the adjacent channel interferer (ACI) and the total wanted aggregated signal. The proposed offset for the wanted signal must be sufficiently above the TX noise generated by one or two uplink CC depending on the operating band under test and the UE capability.

The Primary CC shall fulfill the requirements in R8/9 with all other CCs are deactivated.

For CA bandwidth class A(Table 5.6A-1), the CC meet the requirements of R8/9.

For CA bandwidth class C, there are two options to define ACS:

Option1 is to consider the Pinterferer to the adjacent CC, then the following requirements apply.

The UE shall fulfil the minimum requirement specified in Table 7.5-1 for all values of an adjacent channel interferer up to –25 dBm. The interferer shall be placed adjacent to the PCC on the opposite side of the SCC, when testing the PCC, and vice-versa when testing the SCC. The PCC and SCC downlinks are both activated, but each is tested individually with its respective interferer. The throughput on each CC shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1).

Table 7.5-1: Adjacent channel selectivity

		Aggregated channel bandwidth configuration		
Rx Parameter	**Units**	**50/100 RB**	**75/75 RB**	**100/100 RB**
ACS	dB	[27]	[27]	TBD

Table 7.5-2: Test parameters for Adjacent channel selectivity for CA, Case 1

Rx Parameter	**Units**	**Channel bandwidth of PCC or SCC tested**					
					50 RB	75RB	100RB
Wanted signal mean power	dBm	REFSENS + [14] dB					
$P_{Interferer}$	dBm				REFSENS + [39.5] dB	REFSENS + [39.5] dB	REFSENS + [TBD] dB
$BW_{Interferer}$	MHz				5	5	5
$F_{Interferer}$ (offset)	MHz				7.5+0.0075 / -7.5-0.0075	10+0.0125 / -10-0.0125	12.5+0.0025 / -12.5-0.0025

NOTE:

1. The transmitter shall be set to 4 dB below P_{CMAX_L} at the minimum uplink configuration specified in TS36.101 in Table 7.3.1A-1, with P_{CMAX_L} as defined in clause 6.2.5
2. The interferer consists of the Reference measurement channel specified in Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1 and set-up according to Annex C.3.1
3. The wanted signal mean power is in relation to the REFSENS of each CC, and the interferer power is in relation to the REFSENS of adjacent CC being tested.
4. The frequency offset refers to the center frequency of the adjacent CC being tested, and the $F_{interferer}$ (offset) shall be the same as the adjacent CC in TS36.101 in table 7.5.1-2

Table 7.5-3: Test parameters for Adjacent channel selectivity, Case 2

Rx Parameter	Units	Channel bandwidth of PCC or SCC tested					
					50 RB	75 RB	100RB
Wanted signal mean power	dBm				[-50.5]	[-50.5]	[TBD]
$P_{Interferer}$	dBm	-25					
$BW_{Interferer}$	MHz				5	5	5
$F_{Interferer}$ (offset)	MHz				7.5+0.0075 / -7.5-0.0075	10+0.0125 / -10-0.0125	12.5+0.0025 / -12.5-0.0025

NOTE:

5. The transmitter shall be set to 24 dB below P_{CMAX_L} at the minimum uplink configuration specified in TS36.101 in Table 7.3.1A-1, with P_{CMAX_L} as defined in clause 6.2.5
6. The interferer consists of the Reference measurement channel specified in Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1 and set-up according to Annex C.3.1
7. The frequency offset refers to the center frequency of the adjacent CC being tested, and the $F_{interferer}$ (offset) shall be the same as the adjacent CC in TS36.101 in table 7.5.1-2

Option2 is to consider the Pinterferer to the whole CA, then the following requirements apply.

The UE shall fulfil the minimum requirement specified in Table 7.5-4 for an adjacent channel interferer on either side of two active aggregated CC at a specified frequency offset and for an interferer power up to [-25] dBm.

Table 7.5-4: Adjacent Channel Selectivity for Carrier Aggregation

Parameter	Unit	Transmission bandwidth configuration of Primary/Secondary CC					
					50/100 RB 100/50 RB	75/75 RB	100/100 RB
ACS_CA	dB				[25]	TBD	TBD

A downlink Secondary CC shall be configured at nominal channel spacing to the Primary CC with the Primary CC configured closest the uplink band. The uplink output power shall be set as specified in Table 7.5-5 and Table 7.5-6 with the uplink configuration according to Table 7.3.1A-1 for the applicable CA Band. For UE(s) supporting one uplink, the uplink configuration of the Primary CC shall be in accordance with Table 7.3.2.

The throughput on each CC shall be ≥ 95% of the maximum throughput of the respective reference measurement channel with the lower and upper range of test parameters chosen from the respective Table 7.5-5 and Table 7.5-6 for the following two cases;

- the interferer configured adjacent to the Primary CC,
- the interferer configured adjacent to the Secondary CC,

The reference channels for each CC are specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1). Both downlink CCs are active with the wanted signal level on each component carrier *c* and the interferer power set relative to the following reference (Table 7.5-5 and Table 7.5-6)

$$P_{REF;c} = P_{REFSENS} + 10\log_{10}(N_{RB,c}/N_{RB,PCC})$$

applied to both the UE antenna ports with

- $P_{REFSENS}$ the minimum mean power according to Table 7.3.1 for the Primary CC
- $N_{RB,c}$ the transmission bandwidth configuration of component carrier *c* (Primary or Secondary) and $N_{RB,PCC}$ the transmission bandwidth configuration of the Primary CC.

NOTE: The wanted power spectral density is equal on both CC.

The interferer power offset G_{INT} is defined by

- $G_{INT} = 10 \log_{10}(1+N_{RB,SCC}/N_{RB,PCC})$ + ACS_CA the interferer configured adjacent to the Primary CC,
- $G_{INT} = 10 \log_{10}(1+N_{RB,PCC}/N_{RB,SCC})$ + ACS_CA with the interferer configured adjacent to the Secondary CC,

where ACS_CA is the adjacent channel selectivity for the particular combination of Primary/Secondary CC as specified in Table 7.5-4 and $N_{RB,SCC}$ the transmission bandwidth configuration of the Secondary CC.

Table 7.5-5: Test parameters for Adjacent Channel Selectivity, Case 1

Parameter	Unit	Transmission bandwidth configuration of Primary or Secondary CC					
					50 RB	75 RB	100 RB
Wanted signal mean power per CC	dBm	$P_{REF,c}$ + [14 dB]					
$P_{interferer}$	dBm				$P_{REF,c}$ + [12.5 dB] + G_{INT}	$P_{REF,c}$ + [12.5 dB] + G_{INT}	$P_{REF,c}$ + [12.5 dB] + G_{INT}
$BW_{interferer}$	MHz				5	5	5
$F_{interferer}$ (offset)	MHz				BW_{GB} + 7 (Note 4)	BW_{GB} + 9.25 (Note 4)	BW_{GB} + 11.5 (Note 4)

NOTE 1: The transmitter shall be set 4 dB below P_{CMAX_L} as defined in Clause 6.2.5
NOTE 2: The interferer consists of the Reference Measurement Channel specified in Annex A.3.2 with one-sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A5.2.1 and set-up according to Annex C.3
NOTE 3: The interferer level is set using the reference power $P_{REF,c}$ of the adjacent CC
NOTE 4: The interferer frequency offset is relative to the adjacent CC and shall be further adjusted to $\lfloor F_{interferer}/0.015 \rfloor 0.015 + 0.0075$ MHz to be offset from the sub-carrier raster

Table 7.5-6: Test parameters for Adjacent Channel Selectivity, Case 2

Parameter	Unit	Transmission bandwidth configuration of Primary or Secondary CC					
					50 RB	75 RB	100 RB
Wanted signal mean power per CC	dBm				[-23.5] - G_{INT}	[-23.5] - G_{INT}	[-23.5] - G_{INT}
$P_{interferer}$	dBm	[-25]					
$BW_{interferer}$	MHz				5	5	5
$F_{interferer}$ (offset)	MHz				BW_{GB} + 7 (Note 3)	BW_{GB} + 9.25 (Note 3)	BW_{GB} + 11.5 (Note 3)

NOTE 1: The transmitter shall be set 24 dB below P_{CMAX_L} as defined in Clause 6.2.5
NOTE 2: The interferer consists of the Reference Measurement Channel specified in Annex A.3.2 with one-sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A5.2.1 and set-up according to Annex C.3
NOTE 3: The interferer frequency offset is relative to the adjacent CC and shall be further adjusted to $\lfloor F_{interferer}/0.015 \rfloor 0.015 + 0.0075$ MHz to be offset from the sub-carrier raster

2) CA_X-Y (Inter band non contiguous CA)

3) DLMA (Down link multiple antenna)

4) ULMA (Up link multiple antenna)

For UL-MIMO with dual transmitters and dual receivers, the Rel-8/9 ACS requirements shall apply for dual-layer transmission.

5) CPE (Customer Premises equipment)

Results of a LTE REL-10 intra-band CA Rx requirements study

Background LTE UE Rx requirements have been defined in REL-8 such way that the wanted and interfering signal levels have been defined in relation to REFSENS value with additional delta power. This delta power over REFSENS is needed to be able to do the tests above thermal noise which would otherwise be dominant factor in the tests. For the 15 and 20 MHz channel bandwidths the delta over REFSENS is bigger than for smaller LTE bandwidths thus the test configuration is relaxed for these bandwidths. The relaxation was required because the filtering requirements get more stringent when wanted signal bandwidth increases. The study presented below what are suitable wanted signal levels for LTE REL-10 intra-band CA Rx requirements.

Simulation block diagram

Simulation set-up is illustrated in the below.

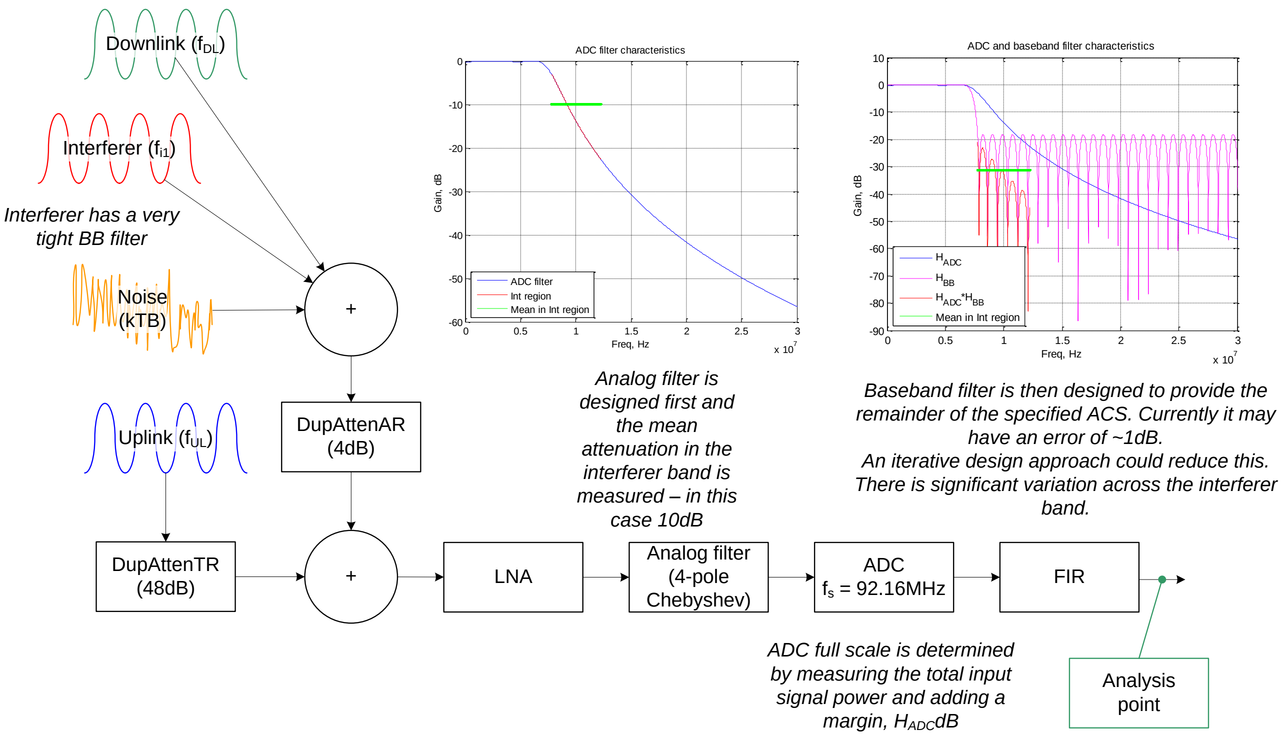


Figure 7.5-2: Simulation set-up

UE receiver chain parameters

Duplexer receive insertion loss = 4 dB

LNA gain = 4 dB

LNA noise figure = 5 dB

LNA IIP3 = -10 … +10 dBm

LNA 1 dB compression point = 10 dB below IIP3)

LNA IIP2 = 56 dBm

Image artefact not modelled.

ADC sample rate = 92.16 MHz

ADC bits = 8

ADC fading margin (above peak power) = 5 dB

SNIR definition

SNIR (Signal to Noise plus Interference Ratio) was used as the figure of merit for the purposes of this evaluation.

The noise-plus-interference power was determined by integrating the power in the downlink component carrier allocated bandwidth for the case where the downlink signal is absent. In this case, we have the following contributions: (i) a transmit leakage signal from the UE, (ii) power from the interferer(s); (iii) thermal noise; (iv) any intermodulation or cross modulation products from these.

SNIR is then determined as the ratio of the signal power specified for the given test to the determined noise-plus-interference power.

Simulation Results

In the simulations three different cases were studied and compared against each other.

- Rel8 specification with 20 MHz DL carrier. In figures below this is "Rel8"
- Rel8 specification applied to 20 MHz+20 MHz DL carriers. This case shows the performance when the wanted signal levels per CC are kept at the same level as in Rel8. In table and figures below this is "Rel8 wanted signal power levels per CC"
- Proposal [4]. This case shows the performance when the wanted signal levels per CC are relaxed by 3 dB due to increased bandwidth. In figures below this is "Relaxed wanted signal power levels per CC"

The simulations shown below are done with several receiver IIP3 values but we use IIP3=-5 dB point as reference in our discussion when we compare the relative difficulty between three cases listed above.

The wanted signal values are collected in table below. Interferer powers are defined in absolute terms and are same as in REL-8 specification in all cases except in ACS case 1 in case marked with * where the interferer powers are defined as aggregated power +22.5 dB. The wanted signal power in ACS case 2 in case marked with ** is different to Rel8 because the interferer at -25 dBm and ACS value set the wanted signal power level per CC.

Table 7.5-7: Wanted signal values

Signal levels in dB	Refsens	ACS case1 Refsens + value below	ACS case2 absolute value in dBm	In-band blocking Refsens + value below	Narrow-band blocking Refsens + value below	Intermodulation Refsens + value below
Rel8	-94 dBm	14	-50.5	9	16	9
Rel8 wanted signal power levels per CC**	-94 dBm	14	-53.5	9	16	9
Relaxed wanted signal power levels per CC*	-94 dBm	14	-50.5	12	19	12

Results are presented as plots were in x-axis LNA IIP3 value is presented and in y-axis SINR value as defined earlier is presented as a figure of merit.

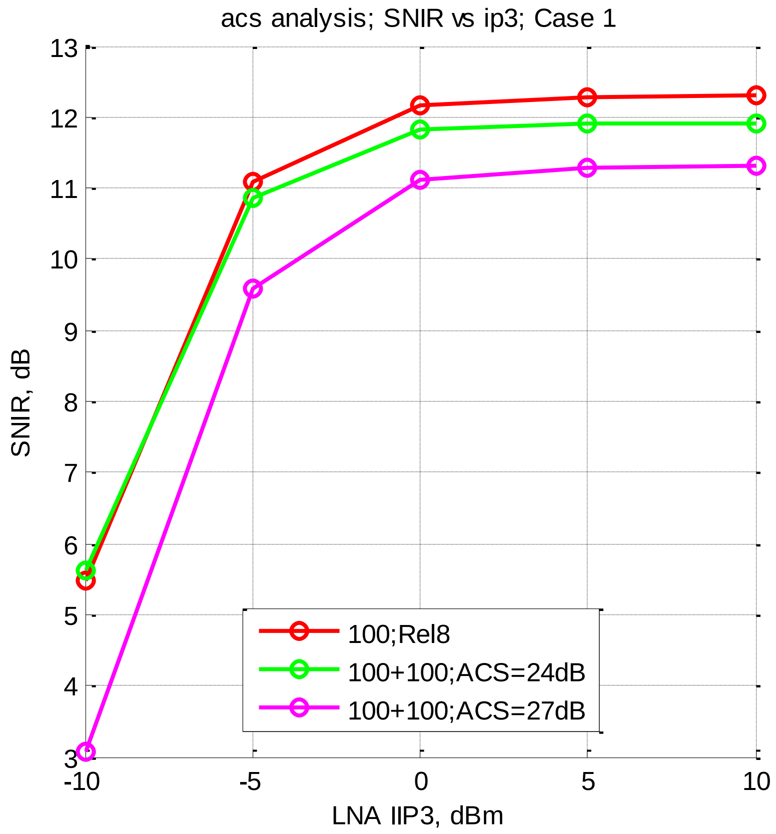


Figure 7.5-3: ACS case1

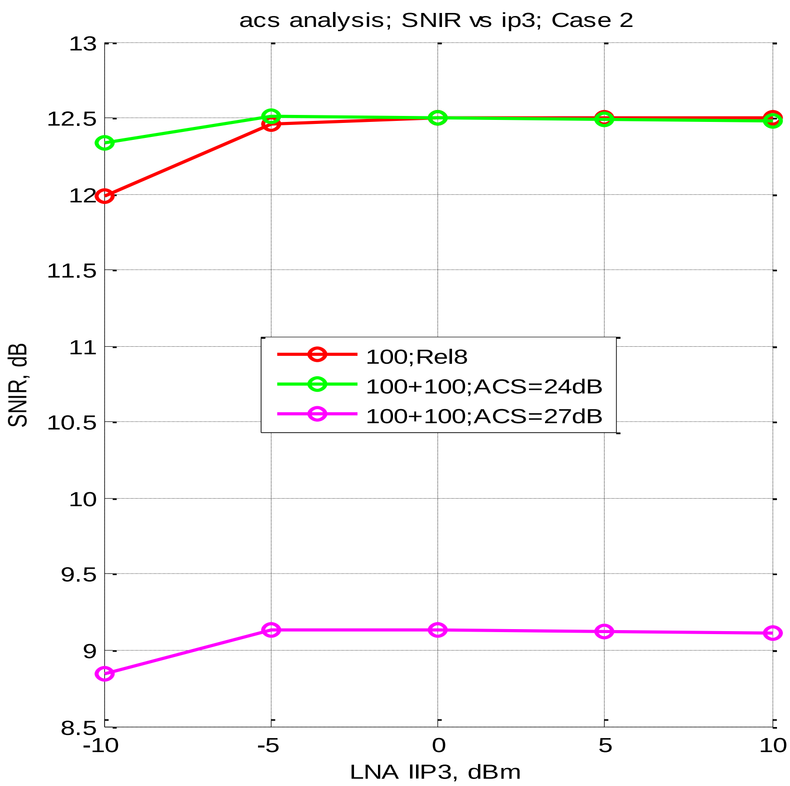


Figure 7.5-4: ACS case2

Figure 7.5-3 and Figure 7.5-4 show that in order to roughly keep the rel8 20 MHz SNIR level, ACS requirement should be relaxed from 27 dB to 24 dB.

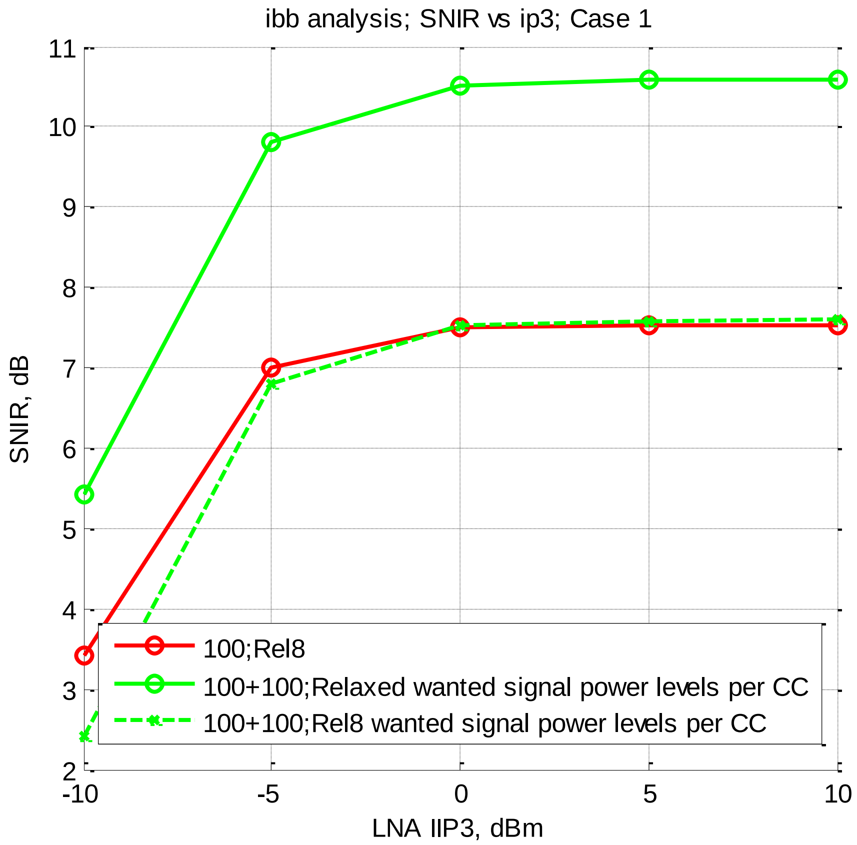


Figure 7.5-5: In-band blocking case1

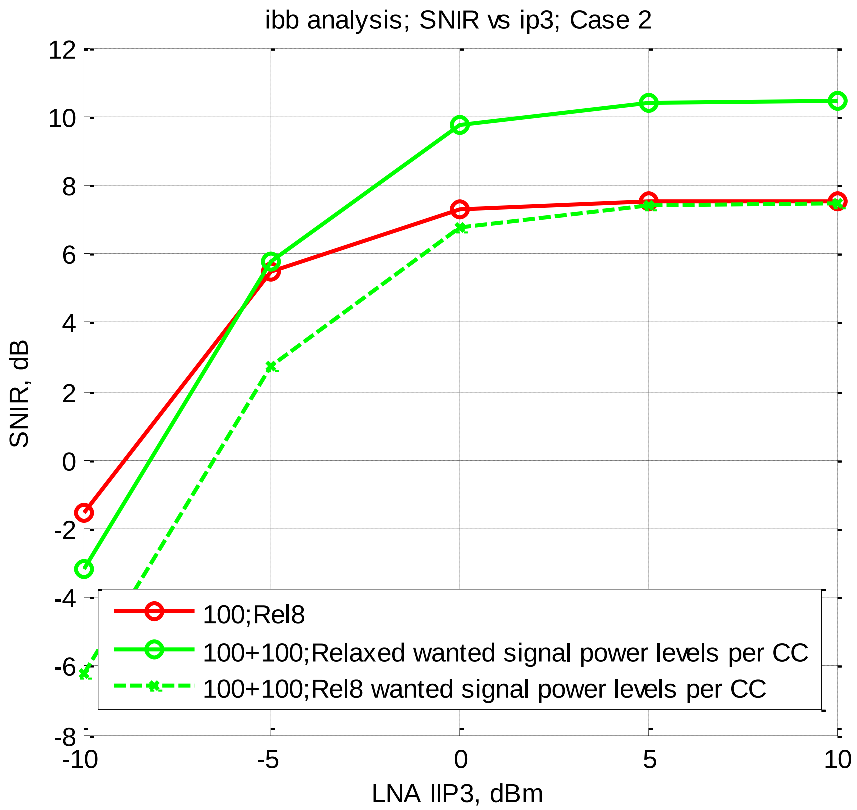


Figure 7.5-6: In-band blocking case2

Figure 7.5-6 shows that in in-band blocking case2, the wanted signal power should be increased by 3 dB per CC to achieve SNIR similar to Rel8 20 MHz. If the wanted signal power is not increased, then SNIR will drop by roughly 3 dB (at IIP3=-5 dB). In-band blocking case1 in Figure 7.5-5 would not require increasing wanted signal power per CC from current Rel8 specification. However, it would seem practical to apply only one wanted signal power level to in-band blocking cases.

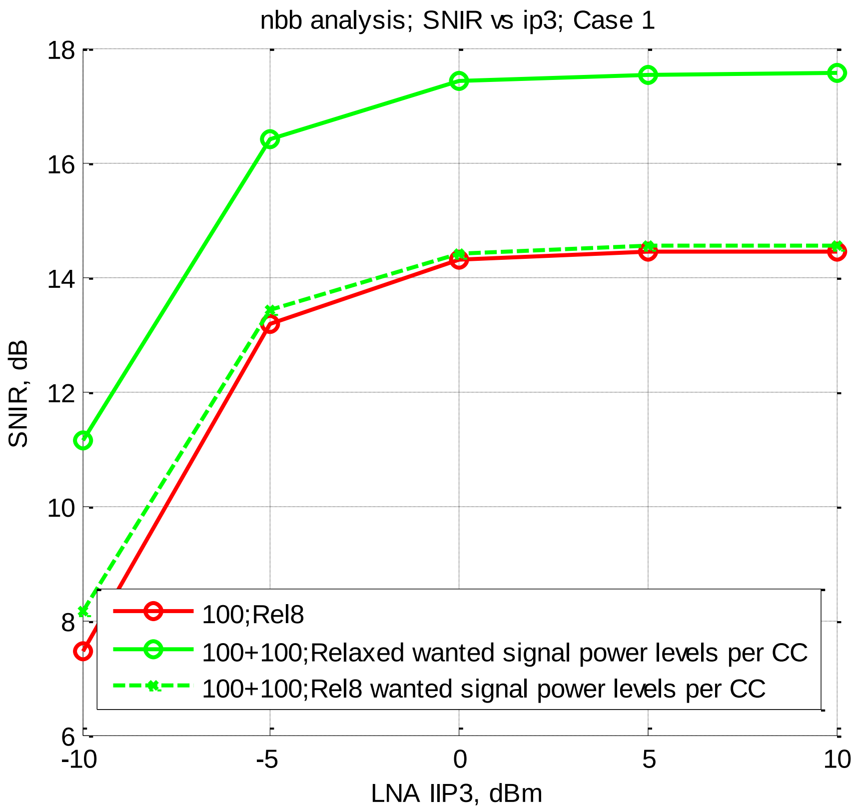


Figure 7.5-7: Narrow-band blocking

Figure 7.5-7 shows that SNIR performance in Rel10 would be similar to that of Rel8 even if the wanted signal power level per CC would not be increased. However, we feel that it might be beneficial to maintain consistency in rel10 specification; if all other cases require increasing the wanted signal power levels per CC, we should consider of exploiting the same approach here as well.

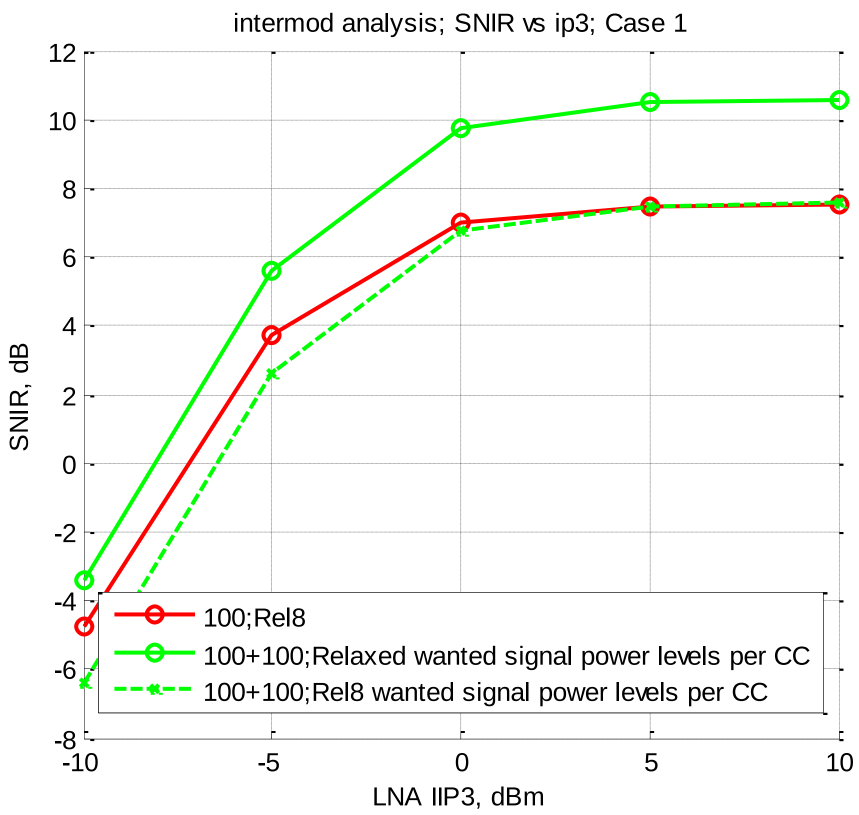


Figure 7.5-8: Intermodulation

Figure 7.5-8 shows that if the rel8 wanted signal power per CC is adopted to Rel10, the SNIR performance degrades by roughly 1.5 dB (at LNA IIP3 of -5 dB). If the wanted signal level per CC is increased by 3dB [4], the SNIR performance increases roughly by 1.5 dB.

Additional Analog filtering simulations

Below we present simple simulation results of the unwanted/wanted signal ratios after analog filter. As said earlier, we think analog filtering requirements should not be excessively tightened. These simulations are done using a basic prototype analog filter with 3rd or 5th order Chebyshev response. The simulation results with whole receiver chain show above should be weighted more when deciding the actual CA UE RX parameters as they show the effect to SNIR performance.

These analog filtering simulations shown below can be used to roughly estimate whether the RX requirements should be changed or not.

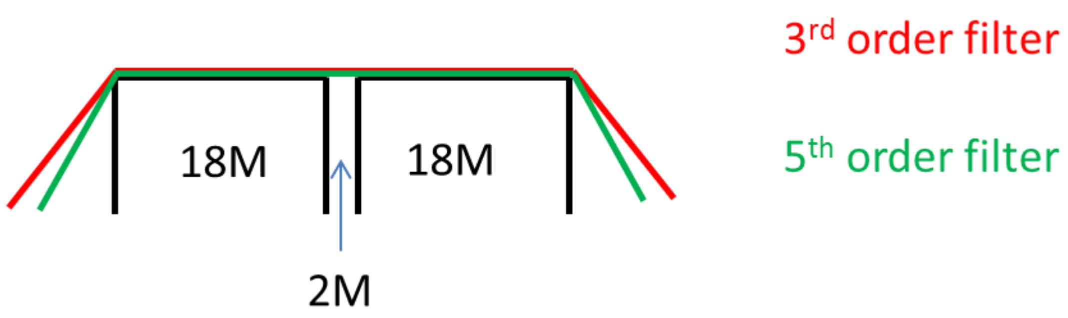


Figure 7.5-9: Prototype filter

Table 7.5-7: Unwanted/wanted signal ratios

Unwanted/Wanted signal ratio in dB	ACS case1		In-band blocking case1		In-band blocking case2		Narrow-band blocking	
Filter order	3	5	3	5	3	5	3	5
Rel8	19.7	16.2	12.3	-1.3	10.9	-12.1	21.4	21.2
Rel8 wanted signal power levels per CC	23.1	22.1	18.0	11.1	20.4	5.6	19.4	19.6
Relaxed wanted signal power levels per CC	20.1	19.1	15.0	8.1	17.4	2.6	16.4	16.6

Unwanted/Wanted signal ratio in dB	Out-of-band blocking range1		Out-of-band blocking range2		Out-of-band blocking range3		Intermodulation	
Filter order	3	5	3	5	3	5	3	5
Rel8 (1)	13.3	-8.3	-0.3	-33.7	6.7	-33.4	21.7	7.0
Rel8 wanted signal power levels per CC (2)	22.3	8.7	12.9	-16.3	20.7	-13.4	28.0	20.2
Relaxed wanted signal power levels per CC (3)	19.3	5.7	9.9	-19.3	17.7	-16.4	25.0	17.2

Table 7.5-7 shows that in order not to excessively tighten analog filtering requirements, the wanted signal power levels per CC should be relaxed in all test cases except narrow-band blocking. This is line with receiver SNIR simulations.

7.6 Blocking characteristics

The blocking characteristic is a measure of the receiver's ability to receive a wanted signal at its assigned channel frequency in the presence of an unwanted interferer on frequencies other than those of the spurious response or the adjacent channels, without this unwanted input signal causing a degradation of the performance of the receiver beyond a specified limit.

- In-band blocking
- Out of -band blocking
- Narrow band blocking

For *LTE-A*

- *Based on single and/or multiple CC channel bandwidths*
- *Power allocation for RB single and/or multiple CC channel bandwidths*
- *Per Rx antenna ports or across all antenna ports*
- *Need to define power allocation and distribution for RB single and/or multiple CC Channel bandwidths due to UE Rx operating point (AGC)*

Requirement that need to be specified for the single and dual CC for the following;

1) CA_X (Intra band contiguous CA)
2) CA_X-Y (Inter band non contiguous CA)
3) DLMA (Down link multiple antenna)

4) ULMA (Up link multiple antenna)

The UE blocking characteristic is specified by the following three requirements,

- In-band blocking
- Out of -band blocking
- Narrow band blocking

For UL-MIMO with dual transmitters and dual receivers, the above requirements specified in Rel-8/9 apply for dual-layer transmission.

5) CPE (Customer Premises equipment)

7.6.1 In-band blocking

7.6.2 Out-of-band blocking.

7.6.3 Narrow band blocking

7.7 Spurious response

Spurious response is a measure of the receiver's ability to receive a wanted signal on its assigned channel frequency without exceeding a given degradation due to the presence of an unwanted CW interfering signal at any other frequency at which a response is obtained i.e. for which the out of band blocking limit is not met.

Note should requirement per specified per CC or all CC

Requirement that need to be specified for the single and dual CC for the following;

1) CA_X (Intra band contiguous CA)
2) CA_X-Y (Inter band non contiguous CA)
3) DLMA (Down link multiple antenna)
4) ULMA (Up link multiple antenna)

For UL-MIMO with dual transmitters and dual receivers, the Rel-8/Rel-9 spurious response requirements apply for dual-layer transmission.

5) CPE (Customer Premises equipment)

7.8 Intermodulation characteristics

Intermodulation response rejection is a measure of the capability of the receiver to receiver 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.

Note For LTE-A; Based on single and/or multiple CC channel bandwidths, Power allocation for RB single and/or multiple CC channel bandwidths and Per Rx antenna ports or across all antenna ports

Requirement that need to be specified for the single and dual CC for the following;

1) CA_X (Intra band contiguous CA)
2) CA_X-Y (Inter band non contiguous CA)
3) DLMA (Down link multiple antenna)
4) ULMA (Up link multiple antenna)
5) CPE (Customer Premises equipment)

7.8.1 Wide band intermodulation

4）ULMA (Up link multiple antenna)

The wide band intermodulation requirement is defined following the same principles using modulated E-UTRA carrier and CW signal as interferer. For UL-MIMO with dual transmitters and dual receivers, the Rel-8/Rel-9 requirements for wide band intermodulation apply for dual-layer transmission.

7.8.2 Void

7.9 Spurious emissions

The spurious emissions power is the power of emissions generated or amplified in a receiver that appear at the UE antenna connector.

Note should requirement per specified per CC or all CC

Requirement that need to be specified for the single and dual CC for the following;

1) CA_X (Intra band contiguous CA)

No changes due to CA are needed

2) CA_X-Y (Inter band non contiguous CA)

3) DLMA (Down link multiple antenna)

No changes due to CA are needed

4) ULMA (Up link multiple antenna)

No changes due to UL-MIMO are needed

5) CPE (Customer Premises equipment)

8 CA Co-existence scenarios relating to OOB and Spurious emission

8.1 General

This section looks at the impact of any spurious emission and out of band emission products between the two CC for the band dependant deployment scenarios listed below. These spurious emissions and OOB emissions may influence:

- Channel bandwidth
- Required OOB emissions or spectrum emission mask
- Spurious emission
- Regulatory requirements
- Reference sensitivity level

8.2 Intra - band CA

8.2.1 CA_40

E-UTRA CA Band	E-UTRA operating Band	Uplink (UL) band				Downlink (DL) band				Duplex mode
		UE transmit / BS receive			Channel BW	UE receive / BS transmit			Channel BW MHz	
		F_{UL_low} (MHz) – F_{UL_high} (MHz)			MHz	F_{DL_low} (MHz) – F_{DL_high} (MHz)				
CA_40	40	2300	–	2400	[40[1)]]	2300	–	2400	[40[1)]]	TDD
[1) For the first phase of LTE TDD CA for UE side, with eventual goal for 50MHz]										

8.2.2 CA_1

E-UTRA CA Band	E-UTRA operating Band	Uplink (UL) band				Downlink (DL) band				Duplex mode
		UE transmit / BS receive			Channel BW MHz	UE receive / BS transmit			Channel BW MHz	
		F_{UL_low} (MHz) – F_{UL_high} (MHz)				F_{DL_low} (MHz) – F_{DL_high} (MHz)				
CA_1	1	1920	–	1980	40	2110	–	2170	40	FDD

8.3 Inter - band CA

8.3.1 CA_1–5

E-UTRA CA Band	E-UTRA operating Band	Uplink (UL) band				Downlink (DL) band				Duplex mode
		UE transmit / BS receive			Channel BW MHz	UE receive / BS transmit			Channel BW MHz	
		F_{UL_low} (MHz) – F_{UL_high} (MHz)				F_{DL_low} (MHz) – F_{DL_high} (MHz)				
CA_1-5	1	1920	–	1980	10[1)]	2110	–	2170	10	FDD
	5	824	–	849	10[1)]	869	–	894	10	
1) Only one uplink component carrier is used in any of the two frequency bands at any time.										

9 CPE

9.1 General

This section looks at the specific RF requirements for CPE deployment. [Note- To avoid duplication it is proposed that the general analysis can be included in TR36.942 once the work in this section is completed].

9.2 CPE deployment scenarios

Two models are proposed for CPE deployment as shown on figure 9.2-1

- **CPE indoor scenario (semi static indoor deployment)**. In this case the form factor for the CPE terminal is similar to a WLAN/ router product. The antenna for the CPE terminal fixed ands is Omni-directional.
- **CPE outdoor scenario (wall mounting fixed deployment).** In the antenna is directional and is located on the outside wall of the building. The CPE unit may be internal or external depending on the form factor of the product.

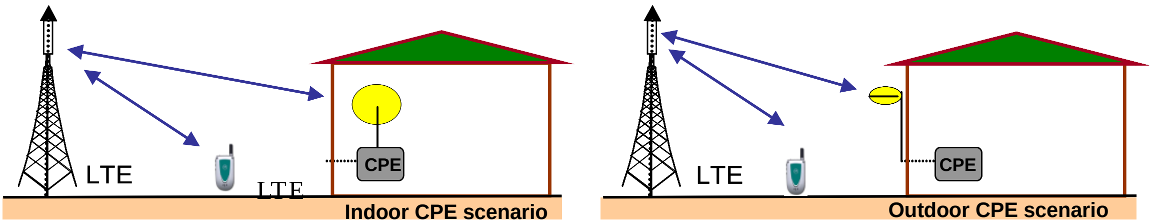


Figure 9.2-1: CPE Deployment scenarios

To account for the different deployment scenario the following antenna gain assumption are used;

- Omni-direction antenna for CPE indoor form factor and deployment scenario.
- Directional antenna for CPE outdoor form factor and deployment scenarios.

9.3 CPE operating band

E-UTRA CPE is designed to operate in operating bands defined in Table 9.3-1.

Table 9.3-1; CPE operating band

E-UTRA CPE Band	E-UTRA operating Band	Uplink (UL) band				Downlink (DL) band				Duplex mode
		UE transmit / BS receive			Channel BW MHz	UE receive / BS transmit			BW MHz Channel	
		F_{UL_low} (MHz) – F_{UL_high} (MHz)				F_{DL_low} (MHz) – F_{DL_high} (MHz)				
CPE_13	13	777	–	787	10	746	–	756	10	FDD

s

9.4 CPE UE Maximum Output Power

The following CPE Power Classes define the maximum output power for any transmission bandwidth within the channel bandwidth.

Table 9.4-1: CPE UE Power Class

CPE band	Class 1 (dBm)	Tolerance (dB)	Class 2 (dBm)	Tolerance (dB)	Class 3 (dBm)	Tolerance (dB)	Class 4 (dBm)	Tolerance (dB)
CPE_13			27	±2	23	±2	n/a	
Note 1. The above tolerances are applicable for UE(s) that support a single CPE E-UTRA operating band 2. Power Class 2 would be considered for CPE indoor form factor and deployment scenario 3. Power Class 3 would be considered for both CPE indoor and outdoor form factor and deployment scenarios								

To account for the different deployment scenario and CPE power class the following assumption are used;

- Power Class 2 (27 dBm) would be considered for CPE indoor form factor and deployment scenario.
- Power Class 3 (23 dBm) would be considered for both CPE indoor and outdoor form factor and deployment scenarios.

9.5 SEM and OOB emission

The spectrum emission mask of the UE applies to frequencies (Δf_{OOB}) starting from the edge of the assigned E-UTRA channel bandwidth. It proposed that the requirements in TS36.101 would be unchanged and the existing band specific requirements would be applicable.

9.6 ACLR

Adjacent Channel Leakage power Ratio (ACLR) is the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency. The current working assumptions for UE ACLR are captured in 6.6.2.3 in TS 36.101 are based on the co-existence simulations outlined in TR 36.942 [7]. These simulations are based on 24 dBm maximum UE transmit power and 0 dBi antenna gain.

For CPE work item we need to review these requirements for the two specified deployment scenarios:

- Omni-directional antenna for CPE indoor deployment scenario with Power Class 2.
- directional antenna for CPE outdoor form deployment scenarios and Power Class 2 and 3.

9.6.1 Simulation methodology and assumptions

In order to perform Band 13 CPE and Band 14 E-UTRA BS co-existence study using static simulations to investigate the impact of CPE interference on E-UTRA BS uplink throughput, the simulation methodology and assumptions specified in TR 36.942 [7] are followed, except the specific parameters given in Table 9.6.1-1 below.

Table 9.6.1-1: Specific parameters for CPE co-existence study

Parameter	Value	Note
E-UTRA channel bandwidth	10 MHz	
Propagation model	Hata Rural (Open Area) propagation model [8] in the 1st phase: L (d) = 69.55 + 26.16*log(f) - 13.82*log(Hb) - [1.1*log(f) - 0.7]*Hm + [1.56*log(f) - 0.8] + [44.9 - 6.55*log(Hb)]*log(d) - 4.78*[log(f)]^2 + 18.33*log(f) - 40.94 Where Hb is BS antenna height in m, Hm is CPE/UE antenna height in m, f is frequency in MHz, d is distance in km.	The Urban area propagation model [7] could be used in the 2nd phase.
Log-normally distributed shadowing margin	10 dB [7]	
Building penetration loss	10 dB [7]	
BS antenna gain minus cable loss	15 dBi [7]	
BS antenna height	60 m [9]	
CPE antenna gain minus cable loss	3 dBi [9] (desktop type) or 7 dBi (wall-mounted type)	
CPE antenna height	1 m [9] (desktop type) or 6 m (wall-mounted type)	
BS <-> UE minimum coupling loss (MCL)	80 dB [7]	
BS <-> desktop CPE minimum coupling loss (MCL)	72 dB [12]	
BS <-> wall-mounted CPE minimum coupling loss (MCL)	67 dB [12]	
Cell range	2 km or 5 km [7]	
Carrier frequency	787 MHz	Uplink frequency border between Bands 13 and 14
Maximum Band 13 CPE power	27 dBm (desktop type) or 23 dBm (wall-mounted type)	
Minimum Band 13 CPE power	-40 dBm [2]	
Maximum Band 14 UE power	23 dBm [2]	
Minimum Band 14 UE power	-40 dBm [2]	
Band 13 desktop CPE location	All Band 13 desktop CPE are indoor	
Band 13 wall-mounted CPE antennas location	All Band 13 wall-mounted CPE antennas are mounted outdoor	
Band 14 UE location	All Band 14 UE are indoor	This is the worse case regarding Band 14 UE uplink capacity loss.
Number of active CPE/UE per cell	3 [7]	RB number per active CPE/UE is 16
UE ACLR for	Considering the 1 MHz frequency gap between the Band 13 and Band 14	The UE ACLR of (30 +

aggressor adjacent to the guard band edge	uplink, the UE ACLR for aggressor adjacent to the guard band edge is obtained by [10]: $ACLR = 10Log\left(\frac{1.88}{2.88\times 10^{30/10}} + \frac{1}{2.88\times 10^{43/10}}\right) = (32 + offset)dB/2.88MHz$ **ACLR values** **Frequency offset between aggressor (16RBs) and victim (16RBs)** — **ACLR value** 0RB + 1MHz frequency gap — 32+*offset* 16RBs + 1MHz frequency gap — 43+*offset* ≥32RBs + 1MHz frequency gap — 43+*offset*	*offset*) dB/2.88MHz [7] for aggressor adjacent to the guard band edge could be used as reference.
Wall-mounted CPE directional antenna pattern	$A(\theta) = -\min\left[12\left(\frac{\theta}{\theta_{3dB}}\right)^2, A_m\right]$ Where θ_{3dB} = 90 degrees, A_m = 15 dB.	
Uplink power control equation	$P_t = P_{\max}\times\min\left\{1, \max\left[R_{\min}, \left(\frac{PL}{PL_{x-ile}}\right)^{\gamma}\right]\right\}$ Where P_{max} is the maximum transmit power, R_{min} is the minimum power reduction ratio to prevent UEs with good channels to transmit at very low power level, *PL* is the path loss for the UE and $PL_{x\text{-ile}}$ is the *x*-percentile path loss (plus shadowing) value [7].	The parameters of the power control equation are given in separate tables.

The parameters of the uplink power control equation in [7] (shown in Table 9.6.1-2 below) is for UE with 23 dBm maximum power, so they can be reused for Band 14 UE and Band 13 wall-mounted CPE to achieve the same receiver SINR target at the BS [11].

Table 9.6.1-2: Power control algorithm parameters for UE and wall-mounted CPE

Parameter set	Gamma	PLx-ile			
		20 MHz bandwidth	15 MHz bandwidth	10 MHz bandwidth	5 MHz bandwidth
Set 1	1	109	110	112	115
Set 2	0,8	TBD	TBD	129	133

For Band 13 desktop CPE with 27 dBm maximum power, the parameters should be increased by 27 – 23 = 4 dB to achieve the same receiver SINR target at the BS [11]. This is shown in Table 9.6.1-3 below.

Table 9.6.1-3: Power control algorithm parameters for desktop CPE

Parameter set	Gamma	PLx-ile			
		20 MHz bandwidth	15 MHz bandwidth	10 MHz bandwidth	5 MHz bandwidth
Set 1	1	113	114	116	119
Set 2	0,8	N/A	N/A	134	138

9.6.2 Simulation results

To investigate the impact of CPE interference on E-UTRA BS uplink throughput, co-existence study using static simulations have been performed. The results are presented in the following tables and figures, according to the scenarios as listed in Table 9.6.2-1 below.

Table 9.6.2-1: List of scenarios for CPE co-existence study

Table and Figure	Scenario
9.6.2-3	Desktop CPE, 27 dBm maximum power, 5 km rural cell range, power control set 1
9.6.2-4	Desktop CPE, 27 dBm maximum power, 5 km rural cell range, power control set 2
9.6.2-5	Desktop CPE, 27 dBm maximum power, 2 km rural cell range, power control set 1
9.6.2-6	Desktop CPE, 27 dBm maximum power, 5 km rural cell range, power control set 2
9.6.2-7	Desktop CPE, 23 dBm maximum power, 5 km rural cell range, power control set 1
9.6.2-8	Desktop CPE, 23 dBm maximum power, 5 km rural cell range, power control set 2
9.6.2-9	Desktop CPE, 23 dBm maximum power, 2 km rural cell range, power control set 1
9.6.2-10	Desktop CPE, 23 dBm maximum power, 2 km rural cell range, power control set 1
9.6.2-11	Wall-mounted CPE, 23 dBm maximum power, 5 km rural cell range, power control set 1
9.6.2-12	Wall-mounted CPE, 23 dBm maximum power, 5 km rural cell range, power control set 2
9.6.2-13	Wall-mounted CPE, 23 dBm maximum power, 2 km rural cell range, power control set 1
9.6.2-14	Wall-mounted CPE, 23 dBm maximum power, 2 km rural cell range, power control set 2

And for each scenario in Table 9.6.2-1, four sets of results are shown in each table and figure as listed in Table 9.6.2-2 below.

Table 9.6.2-2: List of results in each table and figure for each scenario

Sub-table and Sub-figure	Results
(a)	Average E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)
(b)	5% CDF E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)
(c)	Average E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)
(d)	5% CDF E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)

Table 9.6.2-3: Desktop CPE, 27 dBm maximum power, 5 km rural cell range, power control set 1

(a) Average E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	**R4-104612 Huawei**
-15	8.37	7.08	11.00	7.32	8.07
-10	3.42	2.81	4.00	3.37	3.51
-5	1.43	1.01	1.90	1.43	1.38
0	0.50	0.34	0.60	0.56	0.50
5	0.17	0.11	0.20	0.20	0.17
10	0.07	0.04	0.10	0.07	0.06
15	0.01	0.01	0.00	0.02	0.02
(b) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	**R4-104612 Huawei**

-15	12.24	11.10	17.80	10.49	9.58
-10	4.97	5.35	8.30	3.58	2.65
-5	1.44	1.96	1.80	1.13	0.87
0	0.69	1.39	0.80	0.27	0.30
5	0.40	1.35	0.10	0.03	0.13
10	0.06	0.02	0.20	0.00	0.01
15	0.00	0.01	0.00	0.00	0.01
(c) Average E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	
-15	10.07	8.26	13.80	8.15	
-10	4.23	3.44	5.40	3.85	
-5	1.72	1.29	2.20	1.68	
0	0.61	0.45	0.70	0.68	
5	0.20	0.15	0.20	0.26	
10	0.08	0.05	0.10	0.09	
15	0.01	0.01	0.00	0.03	
(d) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	
-15	14.78	11.66	20.20	12.49	
-10	7.43	7.98	9.70	4.61	
-5	2.15	2.09	2.80	1.56	
0	0.91	1.39	0.90	0.43	
5	0.55	1.38	0.20	0.07	
10	0.07	0.02	0.20	0.00	
15	0.00	0.01	0.00	0.00	

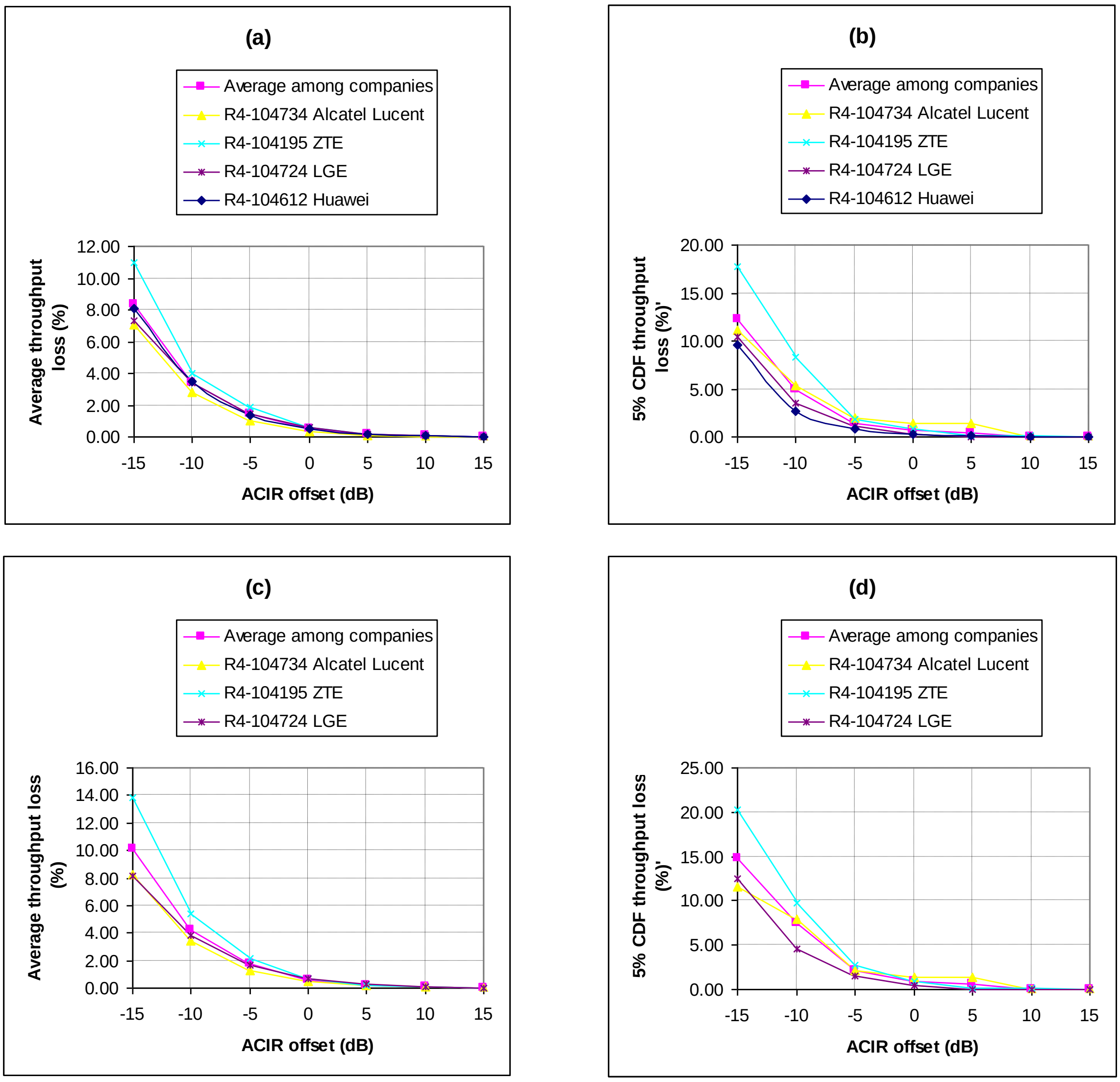


Figure 9.6.2-3: Desktop CPE, 27 dBm maximum power, 5 km rural cell range, power control set 1

Table 9.6.2-4: Desktop CPE, 27 dBm maximum power, 5 km rural cell range, power control set 2

(a) Average E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	**R4-104612 Huawei**
-15	5.63	4.31	8.50	4.49	5.21
-10	2.11	1.55	2.90	1.90	2.09
-5	0.86	0.52	1.40	0.74	0.77
0	0.30	0.17	0.50	0.27	0.26
5	0.11	0.05	0.20	0.09	0.09
10	0.04	0.02	0.10	0.03	0.03
15	0.01	0.01	0.00	0.01	0.01

(b) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	**R4-104612 Huawei**
-15	10.08	9.72	16.10	8.18	6.31
-10	2.38	1.76	3.70	2.65	1.39
-5	0.60	0.73	0.50	0.76	0.40
0	0.24	0.36	0.40	0.16	0.03
5	0.07	0.11	0.10	0.05	0.01
10	0.02	0.04	0.00	0.02	0.00
15	0.01	0.01	0.00	0.01	0.00
(c) Average E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	
-15	7.23	5.27	11.30	5.12	
-10	2.84	1.99	4.30	2.24	
-5	1.06	0.68	1.60	0.91	
0	0.39	0.22	0.60	0.34	
5	0.13	0.07	0.20	0.12	
10	0.05	0.02	0.10	0.04	
15	0.01	0.01	0.00	0.01	
(d) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	
-15	13.56	9.74	21.00	9.93	
-10	3.04	1.76	3.80	3.56	
-5	0.92	0.73	0.90	1.14	
0	0.41	0.56	0.40	0.27	
5	0.12	0.18	0.10	0.07	
10	0.03	0.06	0.00	0.02	
15	0.01	0.02	0.00	0.01	

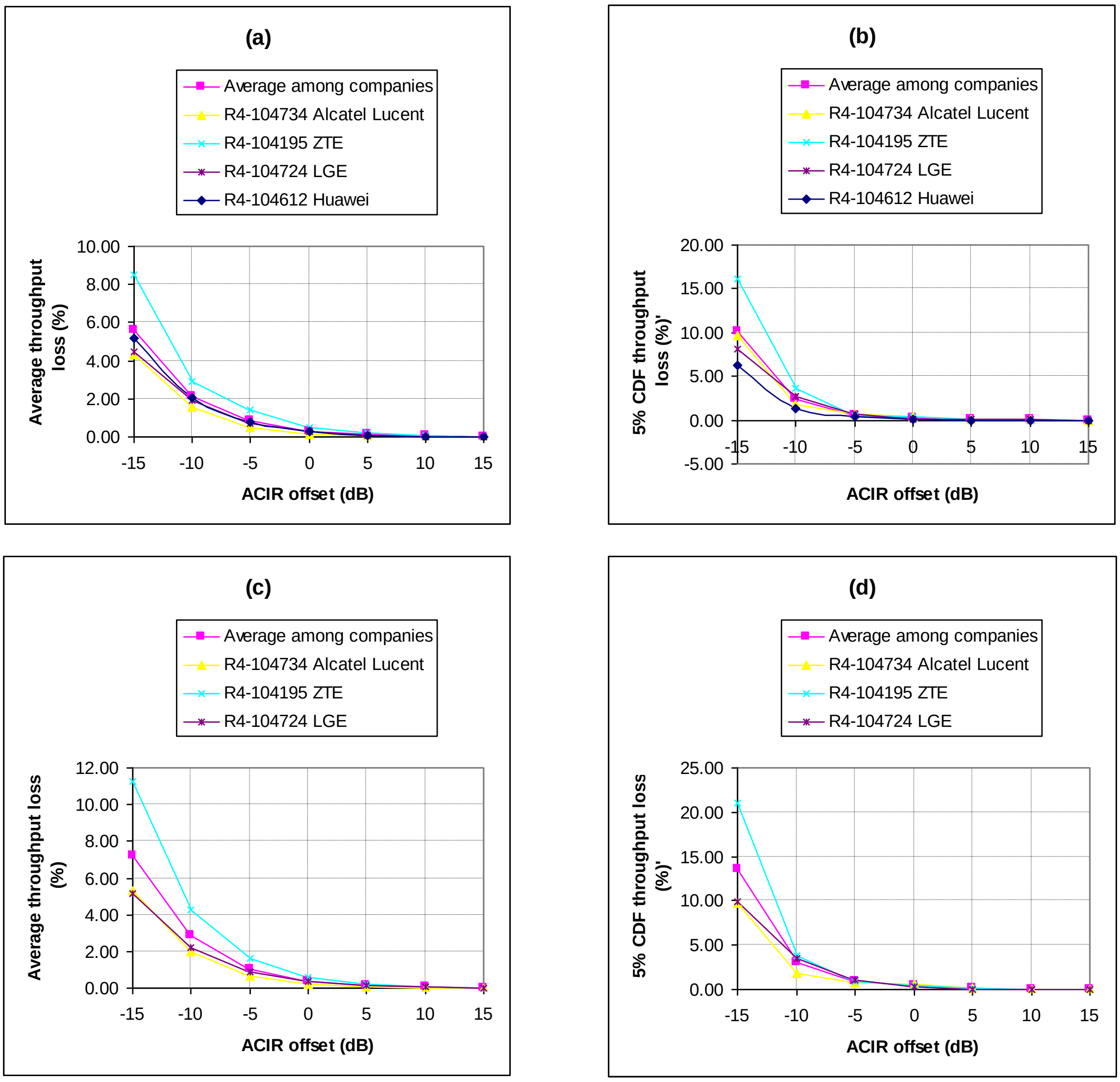


Figure 9.6.2-4: Desktop CPE, 27 dBm maximum power, 5 km rural cell range, power control set 2

Table 9.6.2-5: Desktop CPE, 27 dBm maximum power, 2 km rural cell range, power control set 1

(a) Average E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	**R4-104612 Huawei**
-15	3.08	1.65	3.90	4.00	2.8
-10	1.29	0.56	2.10	1.52	1.0
-5	0.44	0.18	0.70	0.53	0.3
0	0.14	0.06	0.20	0.18	0.1
5	0.05	0.02	0.10	0.06	0.0
10	0.01	0.01	0.00	0.02	0.0
15	0.00	0.00	0.00	0.01	0.0

(b) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	**R4-104612 Huawei**
-15	1.90	0.94	3.00	2.41	1.3
-10	0.59	0.29	1.10	0.61	0.4
-5	0.11	0.04	0.10	0.19	0.1
0	0.03	0.04	0.00	0.06	0.0
5	0.01	0.01	0.00	0.02	0.0
10	0.00	0.00	0.00	0.01	0.0
15	0.00	0.00	0.00	0.00	0.0
(c) Average E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	
-15	3.82	2.10	4.60	4.76	
-10	1.71	0.73	2.50	1.90	
-5	0.58	0.24	0.80	0.69	
0	0.17	0.08	0.20	0.23	
5	0.07	0.02	0.10	0.08	
10	0.01	0.01	0.00	0.02	
15	0.00	0.00	0.00	0.01	
(d) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	
-15	2.81	1.27	3.60	3.55	
-10	1.11	0.29	2.10	0.94	
-5	0.46	0.19	0.90	0.28	
0	0.11	0.06	0.20	0.08	
5	0.01	0.02	0.00	0.02	
10	0.01	0.01	0.00	0.01	
15	0.00	0.00	0.00	0.00	

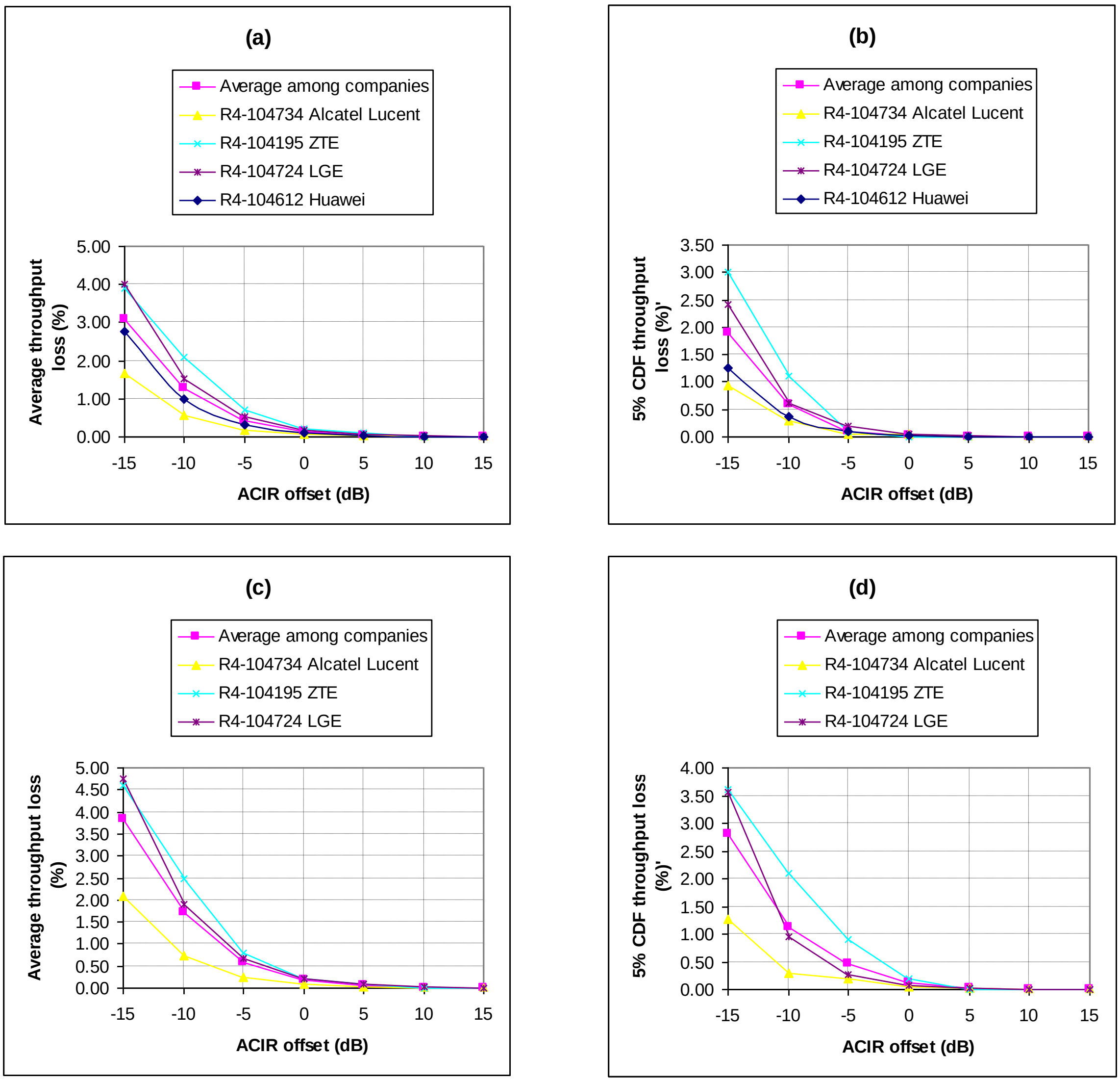


Figure 9.6.2-5: Desktop CPE, 27 dBm maximum power, 2 km rural cell range, power control set 1

Table 9.6.2-6: Desktop CPE, 27 dBm maximum power, 2 km rural cell range, power control set 2

(a) Average E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	**R4-104612 Huawei**
-15	2.44	1.27	3.30	2.72	2.48
-10	0.99	0.42	1.70	0.97	0.85
-5	0.33	0.13	0.60	0.32	0.28
0	0.11	0.04	0.20	0.10	0.09
5	0.02	0.01	0.00	0.03	0.03
10	0.00	0.00	0.00	0.01	0.009
15	0.00	0.00	0.00	0.00	0.003

(b) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	**R4-104612 Huawei**
-15	1.49	0.18	2.20	1.89	1.68
-10	0.52	0.06	1.00	0.52	0.5
-5	0.13	0.02	0.20	0.16	0.15
0	0.02	0.01	0.00	0.05	0.017
5	0.00	0.00	0.00	0.01	0.005
10	0.00	0.00	0.00	0.01	0.002
15	0.00	0.00	0.00	0.00	0
(c) Average E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	
-15	3.00	1.65	4.00	3.34	
-10	1.26	0.55	2.00	1.24	
-5	0.44	0.18	0.70	0.43	
0	0.13	0.06	0.20	0.14	
5	0.05	0.02	0.10	0.04	
10	0.01	0.01	0.00	0.02	
15	0.00	0.00	0.00	0.00	
(d) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	
-15	2.45	0.90	3.50	2.96	
-10	0.67	0.06	1.20	0.76	
-5	0.12	0.02	0.10	0.23	
0	0.03	0.01	0.00	0.07	
5	0.01	0.00	0.00	0.02	
10	0.00	0.00	0.00	0.01	
15	0.00	0.00	0.00	0.00	

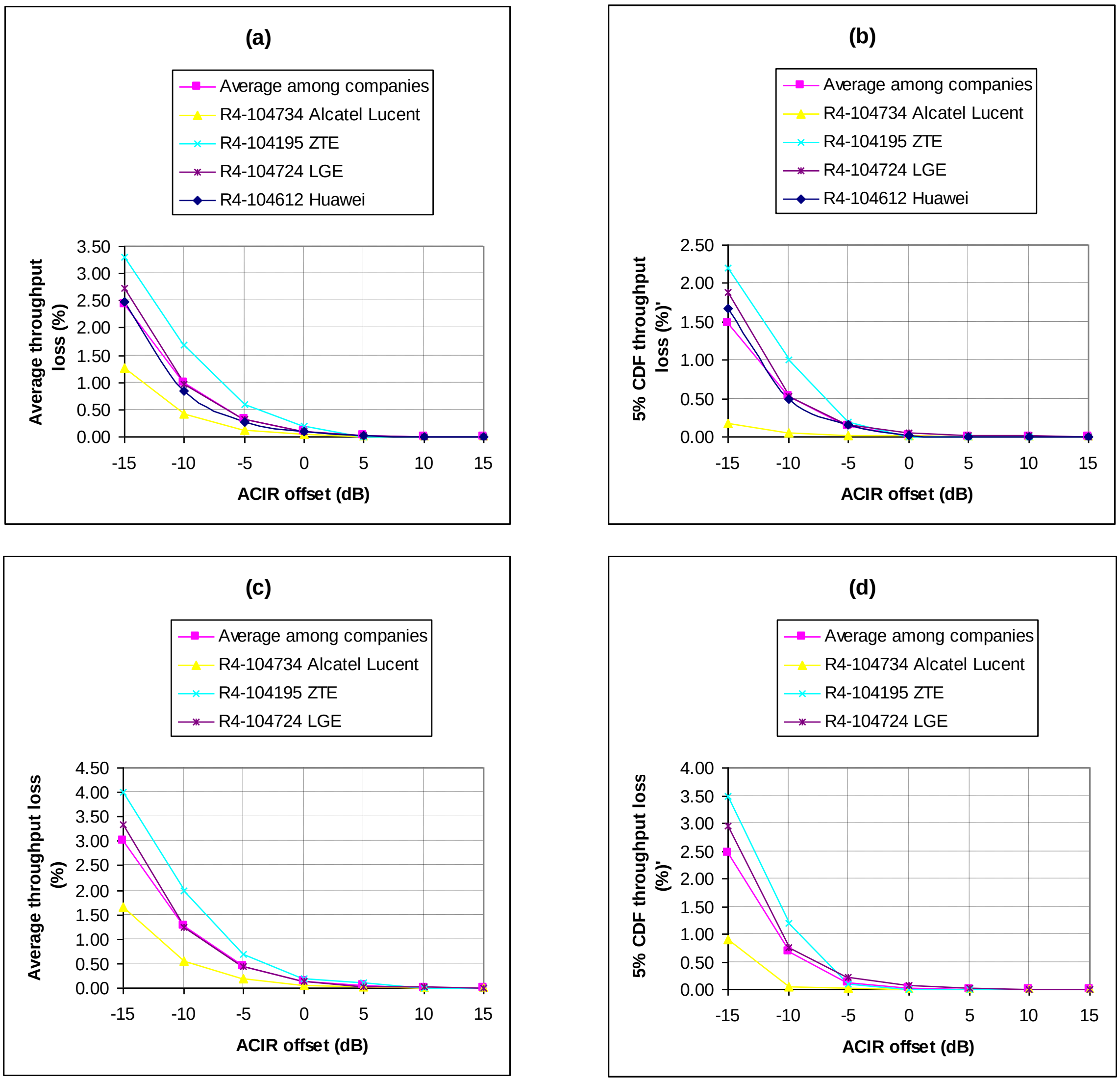


Figure 9.6.2-6: Desktop CPE, 27 dBm maximum power, 2 km rural cell range, power control set 2

Table 9.6.2-7: Desktop CPE, 23 dBm maximum power, 5 km rural cell range, power control set 1

(a) Average E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	**R4-104612 Huawei**
-15	7.62	6.44	9.30	7.08	7.67
-10	3.26	2.53	4.00	3.24	3.28
-5	1.37	0.91	1.90	1.37	1.28
0	0.48	0.30	0.60	0.54	0.46
5	0.16	0.10	0.20	0.20	0.15
10	0.06	0.03	0.10	0.07	0.049
15	0.01	0.01	0.00	0.02	0.02

(b) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	**R4-104612 Huawei**
-15	10.05	10.09	11.50	9.78	8.82
-10	3.42	2.54	5.60	3.28	2.25
-5	1.44	1.94	2.10	1.09	0.62
0	0.57	1.39	0.30	0.31	0.27
5	0.42	1.33	0.20	0.08	0.05
10	0.01	0.02	0.00	0.02	0.01
15	0.01	0.01	0.00	0.01	0.004
(c) Average E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	
-15	9.43	7.60	12.80	7.90	
-10	3.88	3.14	4.80	3.71	
-5	1.70	1.18	2.30	1.61	
0	0.59	0.41	0.70	0.65	
5	0.19	0.13	0.20	0.25	
10	0.08	0.04	0.10	0.09	
15	0.01	0.01	0.00	0.03	
(d) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	
-15	12.28	11.26	13.80	11.77	
-10	5.87	7.97	5.40	4.25	
-5	1.94	2.08	2.20	1.53	
0	0.86	1.39	0.70	0.49	
5	0.56	1.38	0.20	0.11	
10	0.05	0.02	0.10	0.03	
15	0.01	0.01	0.00	0.01	

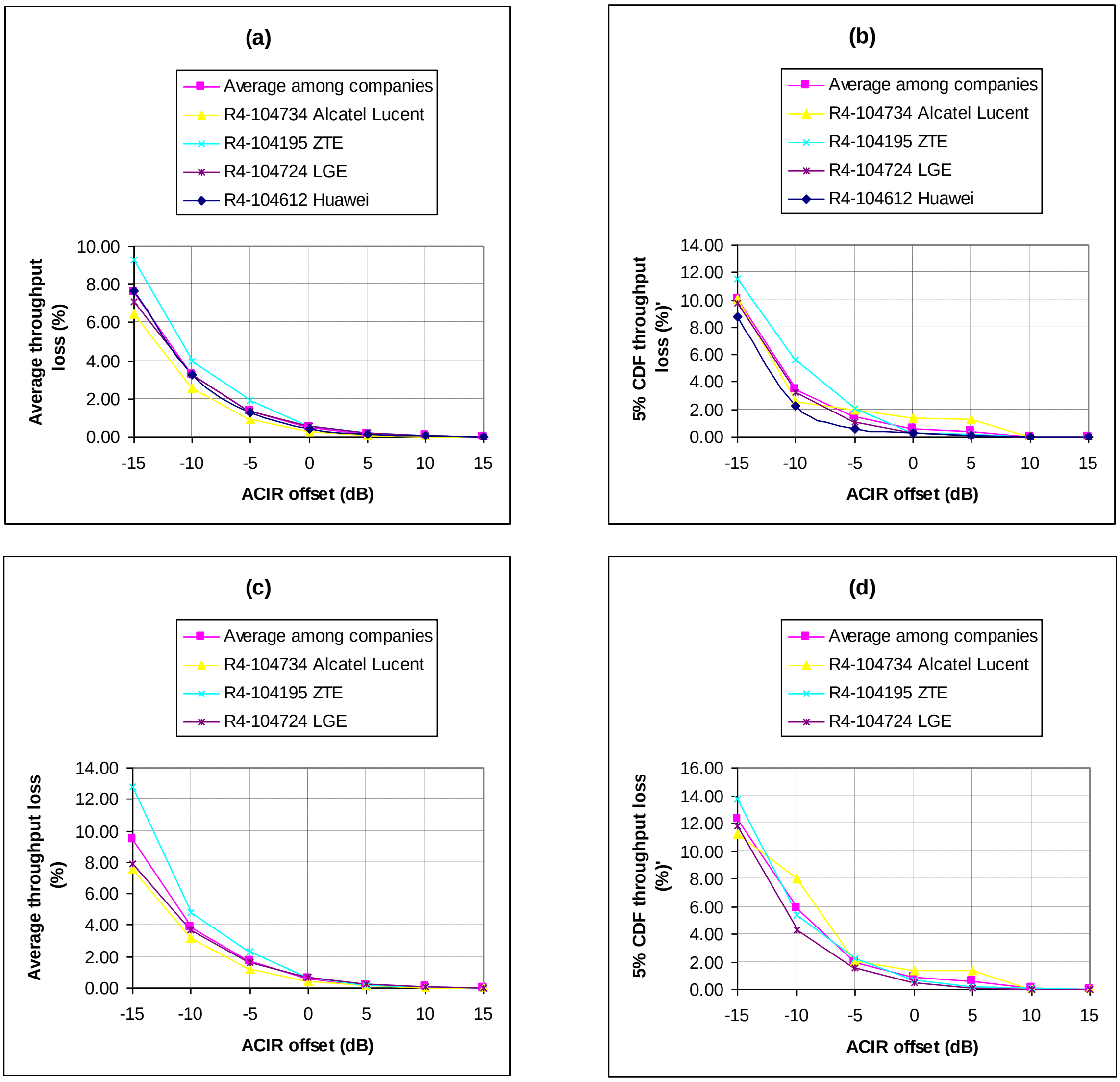


Figure 9.6.2-7: Desktop CPE, 23 dBm maximum power, 5 km rural cell range, power control set 1

Table 9.6.2-8: Desktop CPE, 23 dBm maximum power, 5 km rural cell range, power control set 2

(a) Average E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	Average among companies	R4-104734 Alcatel Lucent	R4-104195 ZTE	R4-104724 LGE	R4-104612 Huawei
-15	5.14	4.29	6.50	4.57	5.21
-10	2.12	1.55	2.90	1.94	2.09
-5	0.86	0.52	1.40	0.76	0.77
0	0.30	0.17	0.50	0.27	0.26
5	0.11	0.05	0.20	0.09	0.087
10	0.04	0.02	0.10	0.03	0.027
15	0.01	0.01	0.00	0.01	0.009

(b) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	**R4-104612 Huawei**
-15	9.15	9.72	12.10	8.45	6.31
-10	2.15	1.72	2.70	2.78	1.39
-5	0.61	0.73	0.50	0.82	0.4
0	0.25	0.36	0.40	0.21	0.031
5	0.07	0.11	0.10	0.06	0.011
10	0.02	0.04	0.00	0.02	0.0032
15	0.01	0.01	0.00	0.01	0.001
(c) Average E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	
-15	6.24	5.24	8.30	5.19	
-10	2.28	1.98	2.60	2.27	
-5	1.07	0.68	1.60	0.92	
0	0.39	0.22	0.60	0.35	
5	0.13	0.07	0.20	0.12	
10	0.05	0.02	0.10	0.04	
15	0.01	0.01	0.00	0.01	
(d) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	
-15	11.68	9.74	15.00	10.30	
-10	3.08	1.72	3.80	3.73	
-5	0.95	0.73	0.90	1.21	
0	0.43	0.56	0.40	0.33	
5	0.12	0.18	0.10	0.09	
10	0.03	0.06	0.00	0.03	
15	0.01	0.02	0.00	0.01	

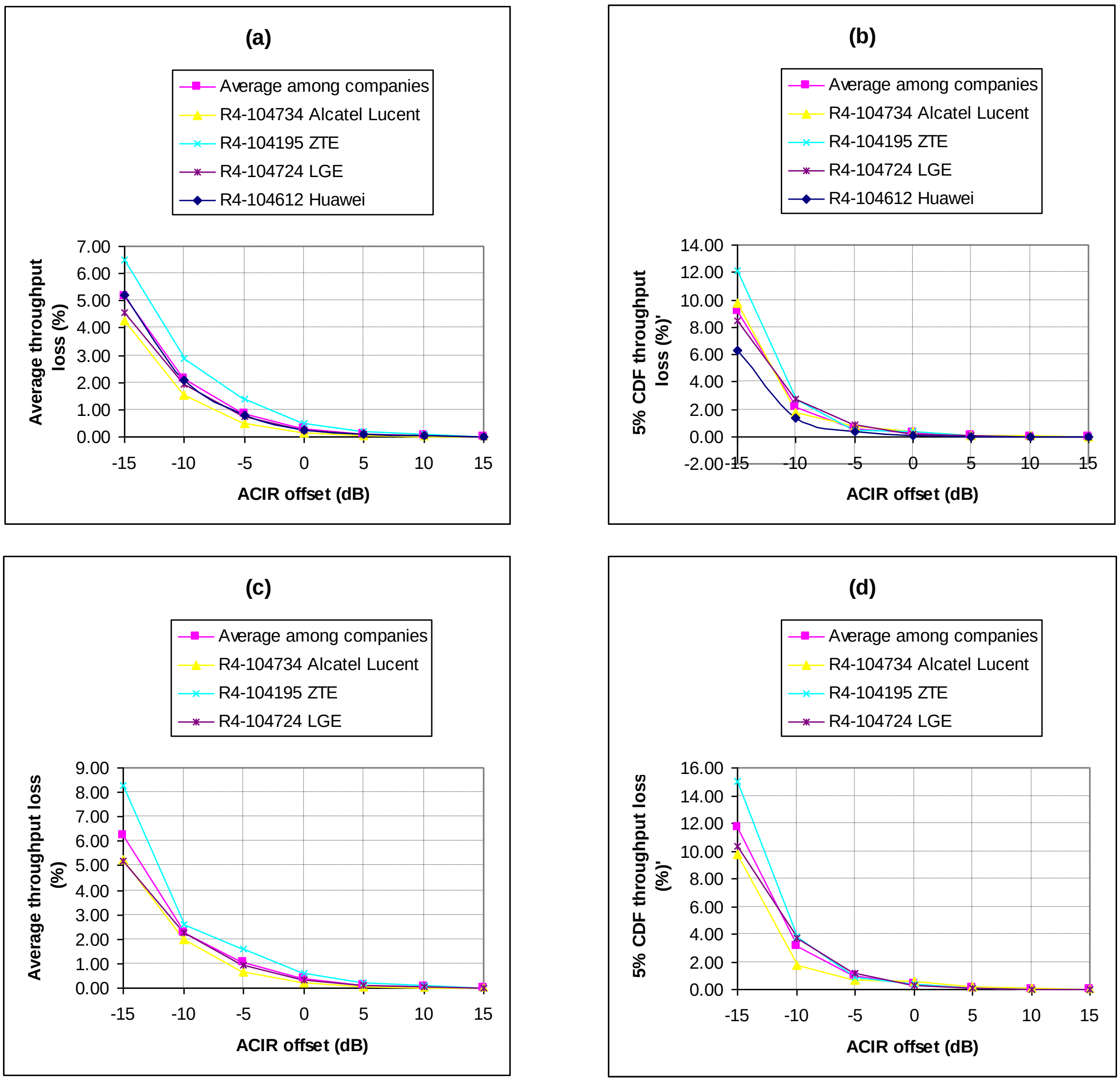


Figure 9.6.2-8: Desktop CPE, 23 dBm maximum power, 5 km rural cell range, power control set 2

Table 9.6.2-9: Desktop CPE, 23 dBm maximum power, 2 km rural cell range, power control set 1

(a) Average E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104724 LGE**	**R4-104612 Huawei**
-15	3.07	1.64	3.90	3.99	2.75
-10	1.31	0.55	2.20	1.51	0.98
-5	0.44	0.18	0.70	0.53	0.33
0	0.14	0.06	0.20	0.18	0.107
5	0.05	0.02	0.10	0.06	0.033
10	0.01	0.01	0.00	0.02	0.011
15	0.00	0.00	0.00	0.01	0.003

(b) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)

ACIR offset (dB)	Average among companies	R4-104734 Alcatel Lucent	R4-104195 ZTE	R4-104724 LGE	R4-104612 Huawei
-15	1.62	0.92	1.90	2.38	1.26
-10	0.54	0.29	0.90	0.59	0.37
-5	0.15	0.12	0.20	0.18	0.11
0	0.06	0.04	0.10	0.05	0.033
5	0.01	0.01	0.00	0.02	0.007
10	0.00	0.00	0.00	0.00	0.002
15	0.00	0.00	0.00	0.00	0

(c) Average E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)

ACIR offset (dB)	Average among companies	R4-104734 Alcatel Lucent	R4-104195 ZTE	R4-104724 LGE	
-15	3.81	2.09	4.60	4.75	
-10	1.71	0.73	2.50	1.89	
-5	0.58	0.24	0.80	0.69	
0	0.17	0.08	0.20	0.23	
5	0.07	0.02	0.10	0.08	
10	0.01	0.01	0.00	0.02	
15	0.00	0.00	0.00	0.01	

(d) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)

ACIR offset (dB)	Average among companies	R4-104734 Alcatel Lucent	R4-104195 ZTE	R4-104724 LGE	
-15	2.90	1.27	3.80	3.64	
-10	1.11	0.29	2.10	0.94	
-5	0.37	0.19	0.70	0.21	
0	0.08	0.06	0.10	0.07	
5	0.01	0.02	0.00	0.02	
10	0.01	0.01	0.00	0.01	
15	0.00	0.00	0.00	0.00	

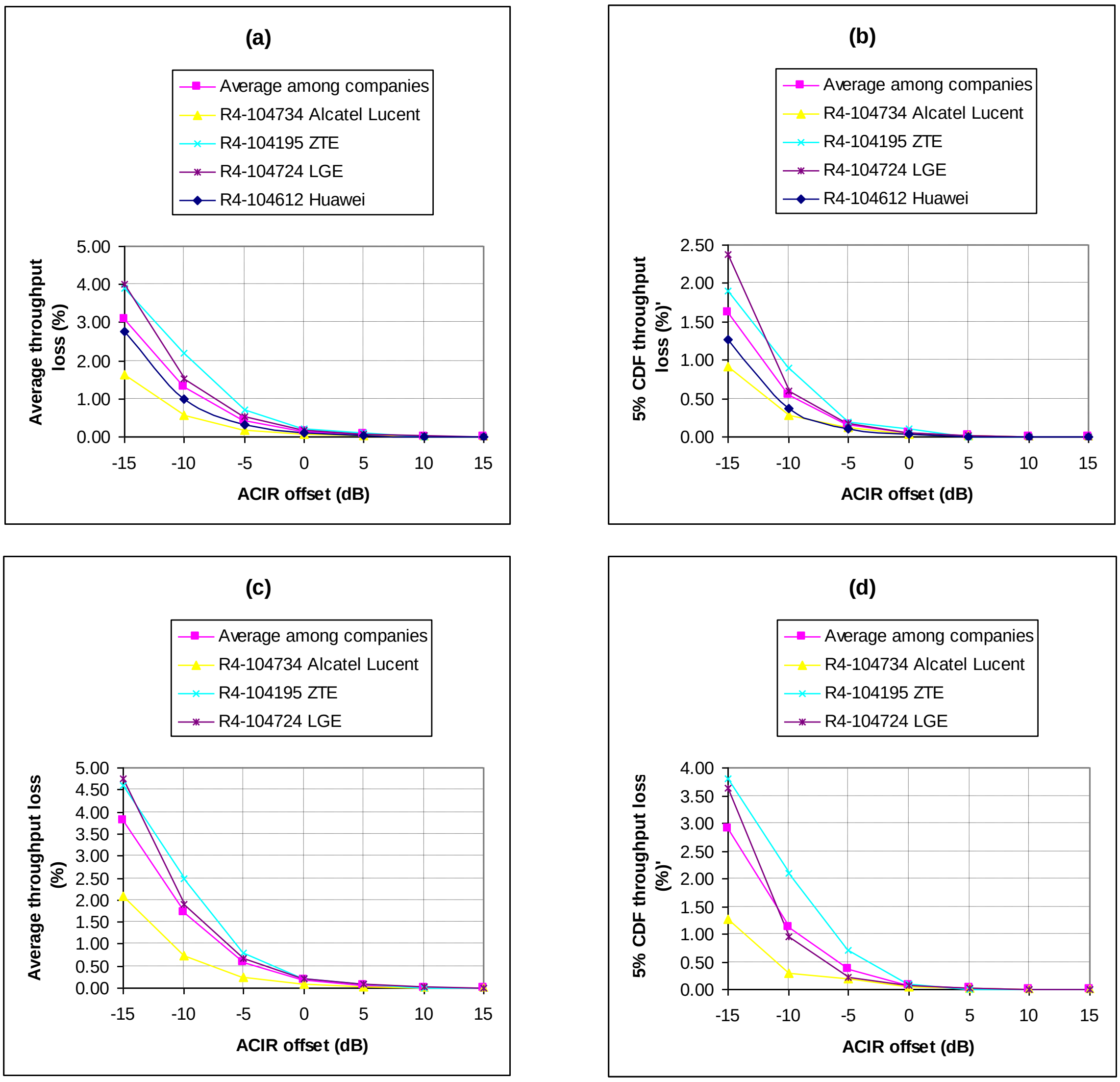


Figure 9.6.2-9: Desktop CPE, 23 dBm maximum power, 2 km rural cell range, power control set 1

Table 9.6.2-10: Desktop CPE, 23 dBm maximum power, 2 km rural cell range, power control set 2

(a) Average E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)

ACIR offset (dB)	Average among companies	R4-104734 Alcatel Lucent	R4-104195 ZTE	R4-104724 LGE	R4-104612 Huawei
-15	2.20	1.27	2.30	2.75	2.48
-10	0.87	0.42	1.20	0.99	0.85
-5	0.34	0.13	0.60	0.33	0.28
0	0.11	0.04	0.20	0.11	0.08
5	0.02	0.01	0.00	0.03	0.028
10	0.00	0.00	0.00	0.01	0.008
15	0.00	0.00	0.00	0.00	0.003

(b) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)

ACIR offset (dB)	Average among companies	R4-104734 Alcatel Lucent	R4-104195 ZTE	R4-104724 LGE	R4-104612 Huawei
-15	1.31	0.18	1.50	1.96	1.61
-10	0.40	0.06	0.50	0.52	0.5
-5	0.13	0.02	0.20	0.16	0.15
0	0.04	0.01	0.10	0.05	0.016
5	0.01	0.00	0.00	0.02	0.005
10	0.00	0.00	0.00	0.00	0.002
15	0.00	0.00	0.00	0.00	0

(c) Average E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)

ACIR offset (dB)	Average among companies	R4-104734 Alcatel Lucent	R4-104195 ZTE	R4-104724 LGE
-15	2.68	1.65	3.00	3.38
-10	1.04	0.55	1.30	1.27
-5	0.44	0.18	0.70	0.44
0	0.13	0.06	0.20	0.14
5	0.06	0.02	0.10	0.05
10	0.01	0.01	0.00	0.01
15	0.00	0.00	0.00	0.00

(d) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)

ACIR offset (dB)	Average among companies	R4-104734 Alcatel Lucent	R4-104195 ZTE	R4-104724 LGE
-15	1.91	0.90	1.80	3.02
-10	0.62	0.06	1.00	0.79
-5	0.22	0.02	0.40	0.23
0	0.09	0.01	0.20	0.07
5	0.01	0.00	0.00	0.02
10	0.00	0.00	0.00	0.01
15	0.00	0.00	0.00	0.00

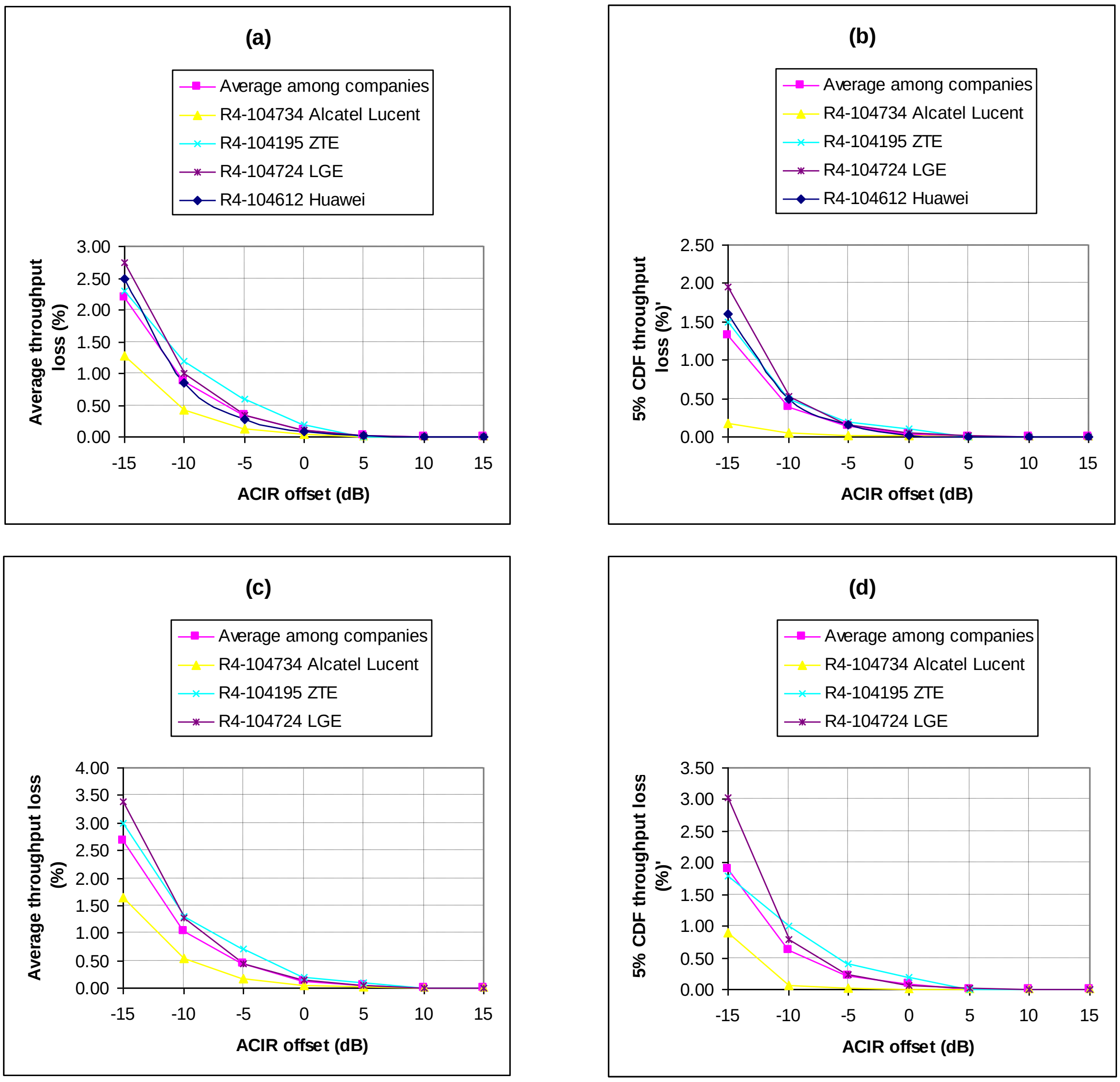


Figure 9.6.2-10: Desktop CPE, 23 dBm maximum power, 2 km rural cell range, power control set 2

Table 9.6.2-11: Wall-mounted CPE, 23 dBm maximum power, 5 km rural cell range, power control set 1

(a) Average E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104723 LGE**	**R4-104612 Huawei**
-15	3.04	3.35	5.40	2.14	1.26
-10	0.88	0.44	1.90	0.74	0.44
-5	0.29	0.14	0.60	0.25	0.15
0	0.09	0.04	0.20	0.08	0.05
5	0.04	0.01	0.10	0.03	0.015
10	0.00	0.00	0.00	0.01	0.004

15	0.00	0.00	0.00	0.00	0
(b) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104723 LGE**	**R4-104612 Huawei**
-15	1.34	1.64	2.20	0.78	0.73
-10	0.35	0.08	0.80	0.25	0.25
-5	0.11	0.02	0.30	0.08	0.04
0	0.04	0.01	0.10	0.02	0.01
5	0.00	0.00	0.00	0.01	0.003
10	0.00	0.00	0.00	0.00	0
15	0.00	0.00	0.00	0.00	0
(c) Average E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104723 LGE**	
-15	3.68	4.26	4.10	2.69	
-10	0.75	0.58	0.70	0.97	
-5	0.27	0.19	0.30	0.33	
0	0.09	0.06	0.10	0.11	
5	0.02	0.02	0.00	0.03	
10	0.01	0.01	0.00	0.01	
15	0.00	0.00	0.00	0.00	
(d) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104723 LGE**	
-15	1.90	2.01	2.50	1.19	
-10	0.44	0.08	0.90	0.34	
-5	0.14	0.02	0.30	0.10	
0	0.05	0.01	0.10	0.03	
5	0.00	0.00	0.00	0.01	
10	0.00	0.00	0.00	0.00	

15	0.00	0.00	0.00	0.00	

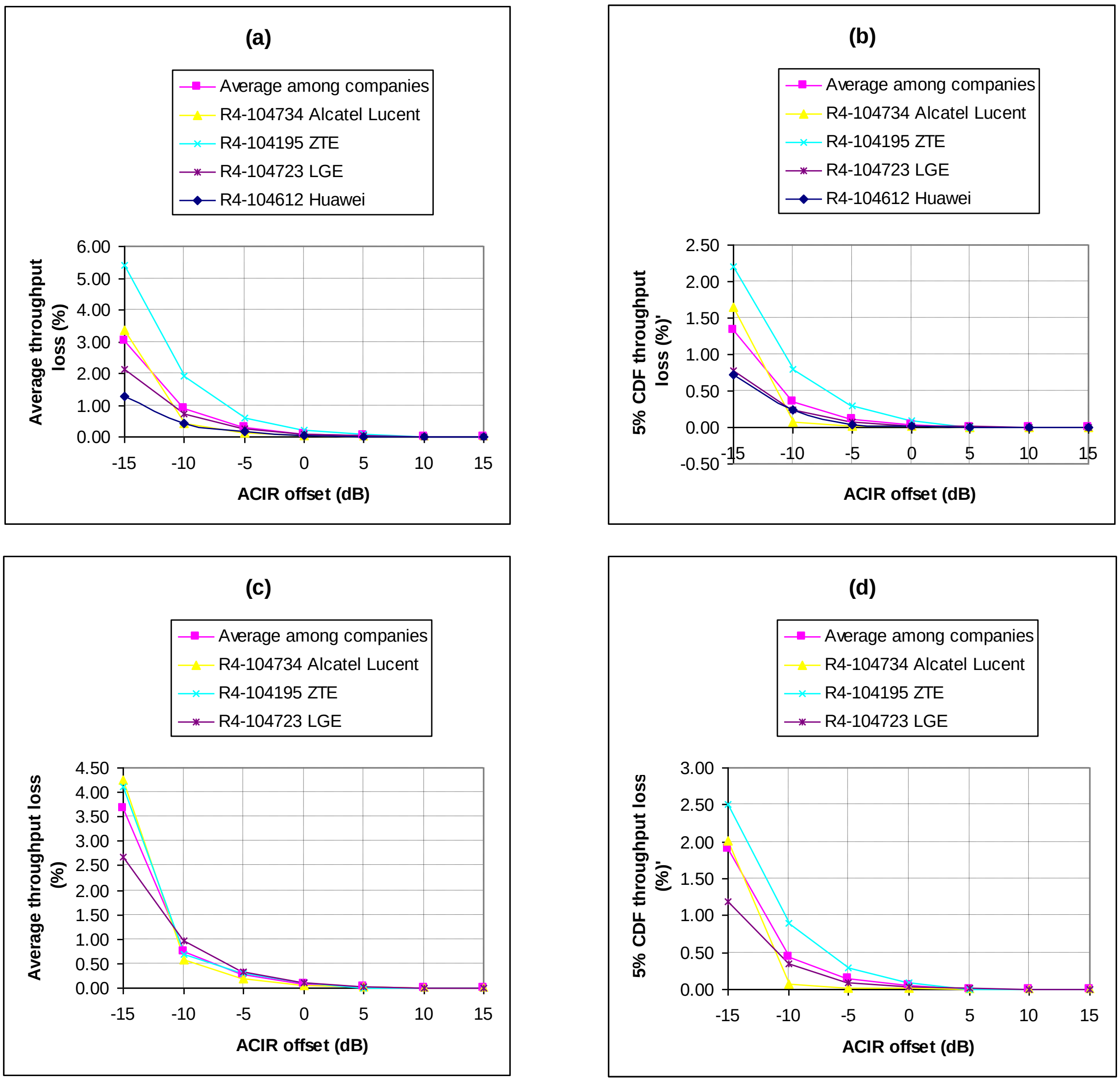


Figure 9.6.2-11: Wall-mounted CPE, 23 dBm maximum power, 5 km rural cell range, power control set 1

Table 9.6.2-12: Wall-mounted CPE, 23 dBm maximum power, 5 km rural cell range, power control set 2

(a) Average E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104723 LGE**	**R4-104612 Huawei**
-15	3.55	4.25	4.90	3.03	2.02
-10	1.01	0.58	1.70	1.05	0.72
-5	0.32	0.18	0.50	0.35	0.24
0	0.11	0.06	0.20	0.11	0.08

5	0.02	0.02	0.00	0.04	0.025
10	0.01	0.01	0.00	0.01	0.008
15	0.00	0.00	0.00	0.00	0
(b) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104723 LGE**	**R4-104612 Huawei**
-15	2.24	2.91	2.80	2.25	0.99
-10	0.54	0.19	1.00	0.58	0.39
-5	0.12	0.02	0.30	0.12	0.05
0	0.01	0.01	0.00	0.03	0.017
5	0.01	0.00	0.00	0.02	0.005
10	0.00	0.00	0.00	0.01	0.002
15	0.00	0.00	0.00	0.00	0
(c) Average E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104723 LGE**	
-15	4.89	5.44	5.40	3.82	
-10	1.39	0.78	2.00	1.38	
-5	0.44	0.25	0.60	0.46	
0	0.14	0.08	0.20	0.15	
5	0.03	0.03	0.00	0.05	
10	0.01	0.01	0.00	0.02	
15	0.00	0.00	0.00	0.00	
(d) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104723 LGE**	
-15	3.50	2.91	4.10	3.50	
-10	0.85	0.38	1.30	0.86	
-5	0.24	0.02	0.50	0.19	
0	0.02	0.01	0.00	0.04	

5	0.01	0.00	0.00	0.03	
10	0.00	0.00	0.00	0.01	
15	0.00	0.00	0.00	0.00	

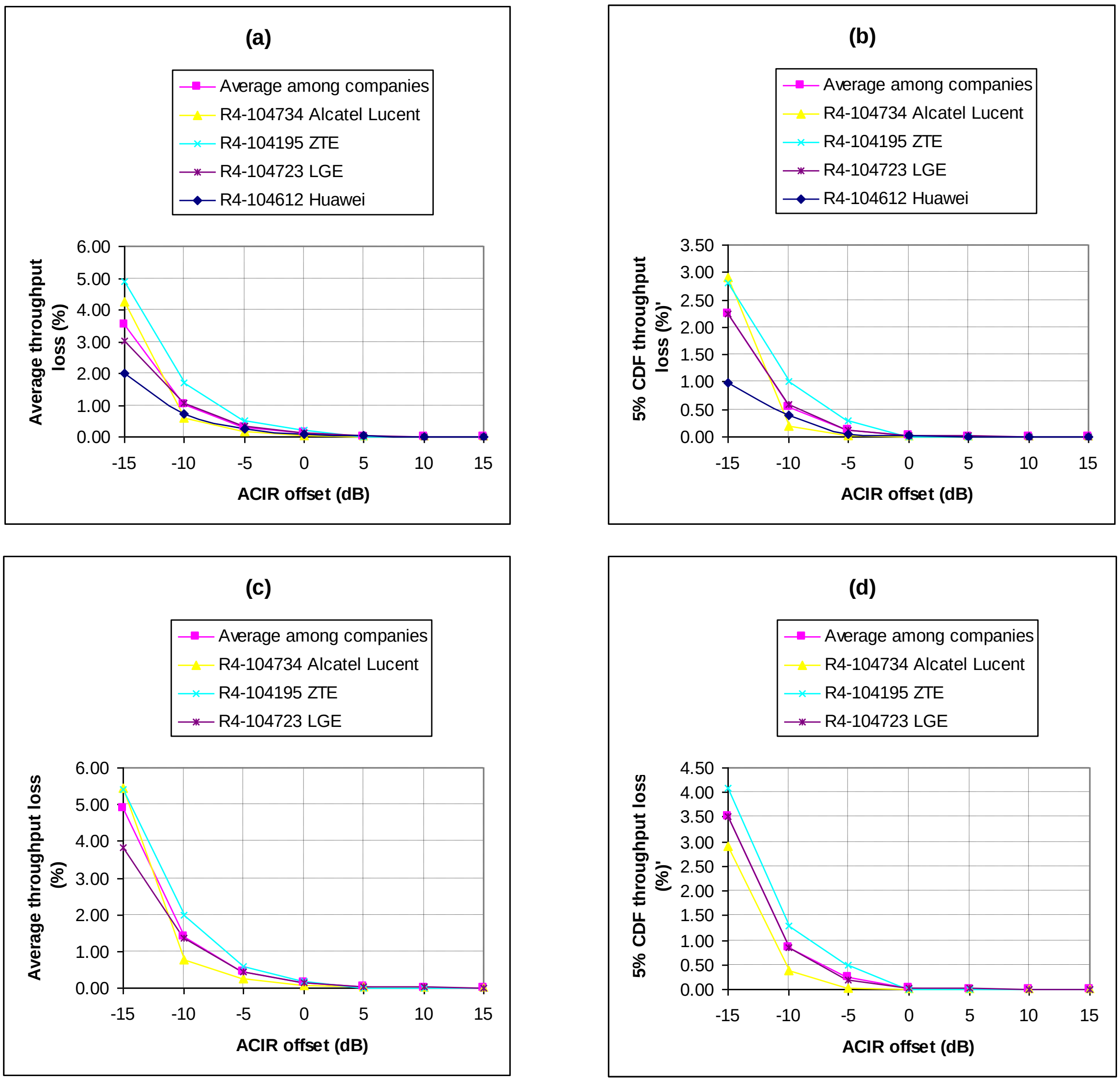


Figure 9.6.2-12: Wall-mounted CPE, 23 dBm maximum power, 5 km rural cell range, power control set 2

Table 9.6.2-13: Wall-mounted CPE, 23 dBm maximum power, 2 km rural cell range, power control set 1

(a) Average E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104723 LGE**	**R4-104612 Huawei**
-15	1.24	1.02	1.90	1.36	0.66
-10	0.36	0.17	0.60	0.44	0.21

-5	0.12	0.05	0.20	0.14	0.07
0	0.05	0.02	0.10	0.05	0.02
5	0.01	0.01	0.00	0.01	0.007
10	0.00	0.00	0.00	0.00	0.002
15	0.00	0.00	0.00	0.00	0
(b) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104723 LGE**	**R4-104612 Huawei**
-15	0.74	1.13	1.20	0.38	0.26
-10	0.25	0.30	0.50	0.14	0.05
-5	0.06	0.07	0.10	0.05	0.01
0	0.01	0.01	0.00	0.01	0.004
5	0.00	0.00	0.00	0.00	0.001
10	0.00	0.00	0.00	0.00	0
15	0.00	0.00	0.00	0.00	0
(c) Average E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104723 LGE**	
-15	1.78	1.35	2.20	1.80	
-10	0.50	0.23	0.70	0.56	
-5	0.19	0.07	0.30	0.19	
0	0.06	0.02	0.10	0.06	
5	0.01	0.01	0.00	0.02	
10	0.00	0.00	0.00	0.01	
15	0.00	0.00	0.00	0.00	
(d) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104723 LGE**	
-15	0.97	1.49	0.90	0.53	
-10	0.39	0.48	0.50	0.19	

-5	0.13	0.13	0.20	0.06	
0	0.01	0.02	0.00	0.02	
5	0.00	0.00	0.00	0.01	
10	0.00	0.00	0.00	0.00	
15	0.00	0.00	0.00	0.00	

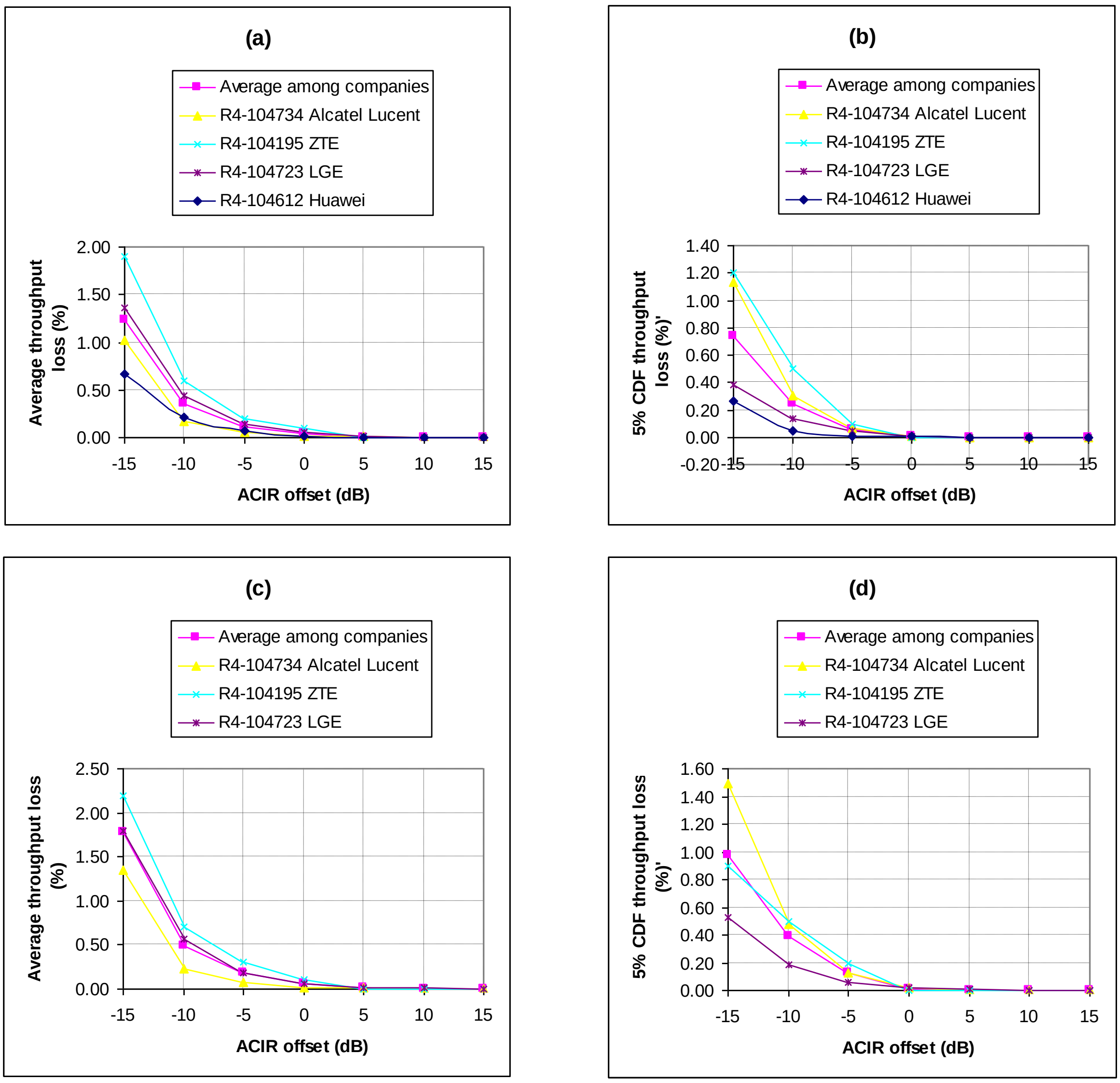


Figure 9.6.2-13: Wall-mounted CPE, 23 dBm maximum power, 2 km rural cell range, power control set 1

Table 9.6.2-14: Wall-mounted CPE, 23 dBm maximum power, 2 km rural cell range, power control set 2

(a) Average E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104723 LGE**	**R4-104612 Huawei**

-15	2.26	1.90	3.00	2.31	1.82
-10	0.57	0.33	0.60	0.76	0.59
-5	0.19	0.10	0.20	0.25	0.19
0	0.07	0.03	0.10	0.08	0.06
5	0.01	0.01	0.00	0.02	0.02
10	0.00	0.00	0.00	0.01	0.01
15	0.00	0.00	0.00	0.00	0.00
(b) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (32+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104723 LGE**	**R4-104612 Huawei**
-15	1.09	0.87	1.60	1.05	0.84
-10	0.42	0.09	1.00	0.33	0.25
-5	0.18	0.03	0.50	0.11	0.09
0	0.07	0.01	0.20	0.04	0.01
5	0.00	0.00	0.00	0.01	0.00
10	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00
(c) Average E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104723 LGE**	
-15	2.62	2.51	2.30	3.04	
-10	0.72	0.44	0.70	1.02	
-5	0.22	0.14	0.20	0.33	
0	0.08	0.04	0.10	0.11	
5	0.01	0.01	0.00	0.03	
10	0.00	0.00	0.00	0.01	
15	0.00	0.00	0.00	0.00	
(d) 5% CDF E-UTRA UL throughput loss (%) Vs ACIR (30+offset, 43+offset)					
ACIR offset (dB)	**Average among companies**	**R4-104734 Alcatel Lucent**	**R4-104195 ZTE**	**R4-104723 LGE**	

-15	1.39	1.49	1.20	1.47	
-10	0.48	0.48	0.50	0.46	
-5	0.16	0.13	0.20	0.15	
0	0.02	0.02	0.00	0.05	
5	0.01	0.00	0.00	0.02	
10	0.00	0.00	0.00	0.01	
15	0.00	0.00	0.00	0.00	

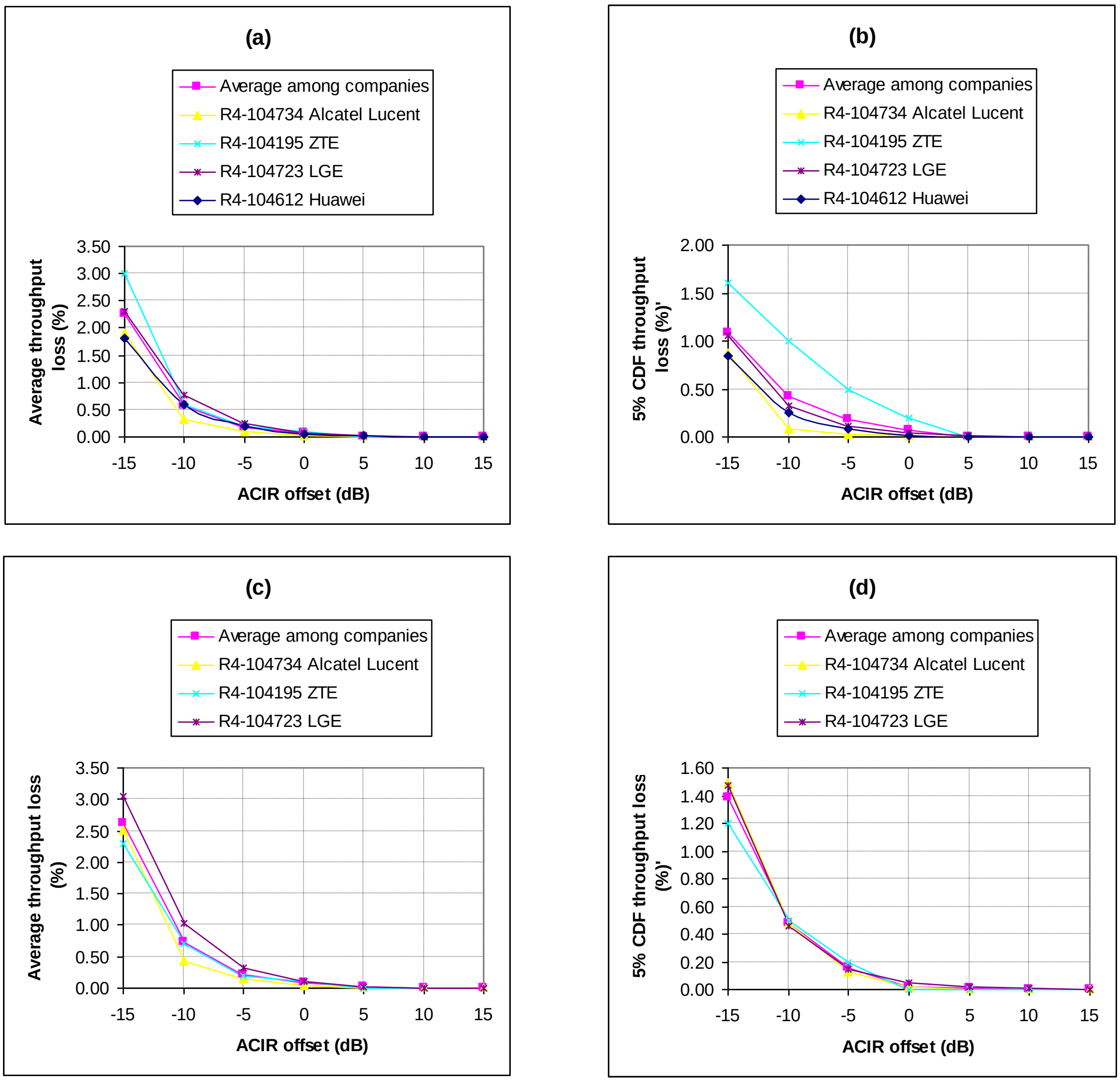


Figure 9.6.2-14: Wall-mounted CPE, 23 dBm maximum power, 2 km rural cell range, power control set 2

9.6.3 Minimum requirements

Based on the uplink coexistence studies between CPE and E-UTRA BS, it is proposed that the ACLR requirement defined in TS 36.101 Clause 6.6.2.3 shall be reused for CPE.

9.7 FFS

9.8 Band 13

This section looks at the band 13 specific requirements that would need to be specified:

- Spurious emission and CPE to UE co-existence
- REFSENS
- Others

9.8.1 B13 Spurious emission and CPE to UE co-existence

The main co-existence aspect that needs to be addressed is CPE to UE co-existence as shown below in figure 9.8.1 and for the deployment assumptions detailed in table 9.8-1.

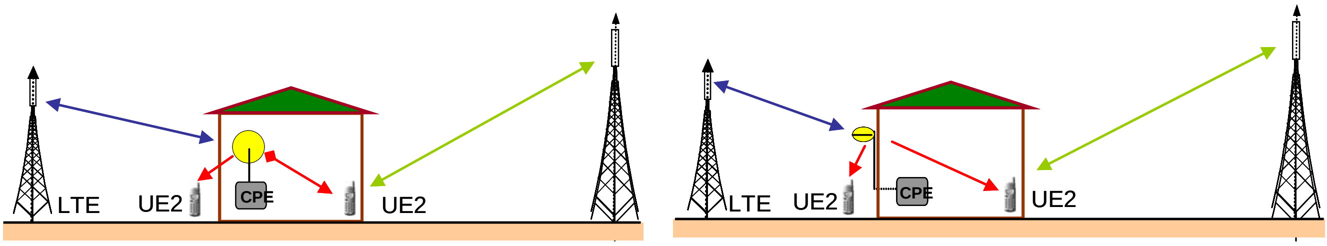


Figure 9.8.1-1: B13 CPE indoor and outdoor deployment UE2 co-existence

Table 9.8.1-1: Deployment assumptions for deterministic co-existence analysis

Parameters	**CPE Indoor deployment scenario**		**CPE Outdoor deployment scenario**	
	CPE to outdoor UE	**CPE to indoor UE**	**CPE to outdoor UE**	**CPE to indoor UE**
	Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 4**
Target band/ frequency for co-existence analysis	[ ] MHz	[ ] MHz	[ ] MHz	[ ] MHz
CPE terminal maximum power	27/23 dBm	27/23 dBm	23 dBm	23 dBm
CPE terminal Antenna gain (minus cable loss)	TBD	TBD	TBD	TBD
CPE terminal Antenna radiation pattern	360°	360°	TBD° [2]	TBD° [2]
CPE terminal antenna height	1 m	1 m	6 m	6 m
CPE terminal effective Antenna patten gain	-	-	TBD	TBD
LTE BS antenna height	60 m	60 m	60 m	60 m
LTE BS antenna gain (minus cable loss (dBi)	15 dBi	15 dBi	15 dBi	15 dBi
Building penetration loss	10 dB	n/a	n/a	10 dB
UE2 antenna gain	-10 dBi[1]	-10 dBi[1]	-10 dBi[1]	-10 dBi[1]
UE2 terminal antenna height	1.5 m	1.5 m	1.5 m	1.5 m
CPE emission target				
Note 1. Assumes head and hand losses for handset deployment 2. Taking into account out door CPE antenna pattern				

The above deployment assumptions in Table 9.8-1 are based on worst case deterministic analysis. Further work is needed to account for more realistic deployment scenario to account for; power control, cell size, directional antenna pattern etc.

9.8.1.1 B13 CPE RFSENS

Self interference is a function of Tx – Rx spacing, duplex filter performance, Tx power and transmitted RB(s). For a fixed duplex gap the self interference increases with channel bandwidth, transmit power class and RB allocation.

Annex A: CA deployment scenarios

A.1 General

A.2 Intra - band Contiguous CA

As discussed so far, one of the most likely candidates for Intra-band Contiguous CA is 3.5 GHz (Scenario #1 for LTE-A feasibility study). However, the band arrangement in 3500 MHz for IMT-Advanced is still on-going or FFS in ITU-R and each country, and it would be wise to postpone the RAN4 work for 3.5 GHz for LTE-Advanced until Release 11 (beyond 2010), in which the band arrangement would be clarified in each country.

Other possible band scenarios for this scenario are 2600 MHz for FDD and 2300/2600 MHz for TDD based on the operators' feedbacks. Therefore, it is proposed that the following band scenarios should be studied for Intra-band Contiguous CA in Release 10 WI. Band scenarios are presented in Table 1.

(Proposed band scenarios)

- ***FDD: UL: 40 MHz, DL: 40 MHz in Band 7 (2600 MHz)***
- ***TDD: UL/DL: 50 MHz in Band 40 (2300 MHz)***
- ***TDD: UL/DL: 40 MHz in Band 38 (2600 MHz)***

Table 1: Operator proposed CA scenarios - Intra-band contiguous

Transmission bandwidth	Number of LTE-A component carriers	Duplex mode	Region
UL: 40 MHz DL: 40 MHz	20 MHz CC + 20 MHz CC + TBD (Band 3)	FDD	Region 1
UL/DL: 50 MHz	20 MHz CC + 20 MHz CC + 10 MHz + TBD (Band 40)	TDD	Region 3
UL: 40 MHz DL: 40 MHz	20 MHz CC + 20 MHz CC + TBD (Band 7)	FDD	Region 1
UL/DL: 40 MHz	20 MHz CC + 20 MHz CC + 10 MHz + TBD (Band 38)	TDD	Region 2

Note: TBD means smaller carrier to maximize the spectrum allocations. It would be carrier segment or extension carrier or normal component carrier.

A.3 Inter band Non - Contiguous CA

Table 2-5 present band scenarios, which have been proposed so far by operators co-signing this contribution. Based on the agreed approach, i.e. prioritizing/limiting band scenarios per region, it is proposed that the following band scenarios should be studied for Inter-band Non-contiguous CA in Release 10 WI.

(Proposed band scenarios)

- ***Region 1***
  - 40 MHz UL/DL: 20 MHz CC (Band 7) + 20 MHz CC (Band 20)
  - 40 MHz UL/DL: 20 MHz CC (Band 3) + 20 MHz CC (Band 20)
  - 40 MHz UL/DL: 20 MHz (Band 7) + 20 MHz CC (Band 3)

NOTE 1: The UL and DL transmission bandwidths are the maximum configurable bandwidths considered for Rel-10. Re-8/Rel-9 LTE transmission bandwidths should be possible to use in order to allow also for lower total bandwidth CC combinations.

- ***Region 2***
  - 20 MHz UL/DL: 10 MHz CC (Band 5) + 10 MHz CC (Band 12), FDD
  - 10 MHz UL/DL:5 MHz CC (Band 17) + 5 MHz CC (Band 4), FDD
  - 20 MHz UL/DL: 10 MHz CC (Band 13) + 10 MHz CC (Band 4), FDD
  - 20 MHz UL/DL: 10 MHz CC (Band 13) + 10 MHz CC (Band 12), FDD
  - 20 MHz UL/DL:10 MHz CC (Band 2) + 10 MHz CC (Band 4), FDD
  - 10 MHz UL/DL: 5 MHz CC (Band 18) + 5 MHz CC (Band 2), FDD

- ***Region 3***
  - 20 MHz UL/DL: 10 MHz CC (Band 1) + 10 MHz CC (Band 19)
  - 20 MHz UL/DL: 10 MHz CC (Band 11) + 10 MHz CC (Band 18)
  - 40 MHz UL/DL: 20 MHz CC (Band 38) + 20 MHz CC (Band 40)
  - 20 MHz UL/DL: 10 MHz CC (Band 3) + 10 MHz CC (Band 5 or 8)
  - 20 MHz UL/DL: 10 MHz CC (Band 1) + 10 MHz CC (Band 5), FDD
  - 15 MHz UL/DL: 5 MHz CC (Band 1 + 10 MHz CC (Band 8), FDD

Table 2: Operator proposed CA scenarios - (High band + Low band) combination

Transmission bandwidth	**Number of LTE-A component carriers**	**Duplex mode**	**Region**
UL: 40 MHz DL: 40 MHz	20 MHz CC (Band 7) + 20 MHz CC (Band 20)	FDD	Region 1
UL: 40 MHz DL: 40 MHz	20 MHz CC (Band 3) + 20 MHz CC (Band 20)	FDD	Region 1
UL: 20 MHz DL: 20 MHz	10 MHz CC (Band 13) + 10 MHz CC (Band 4)	FDD	Region 2
UL: 10 MHz DL: 10 MHz	5 MHz CC (Band 17) + 5 MHz CC (Band 4)	FDD	Region 2
UL: 15 MHz DL: 15 MHz	10 MHz CC (Band 17) + 5 MHz CC (Band 4)	FDD	Region 2
UL: 10 MHz DL: 10 MHz	(Beyond R10) 5 MHz CC (Band 4) + 5 MHz CC (Band 5)	FDD	Region 2
UL: 10 MHz DL: 10 MHz	(Beyond R10) 5 MHz CC (Band 17) + 5 MHz CC (Band 2)	FDD	Region 2
UL: 20 MHz DL: 20 MHz	10 MHz CC (Band 2) + 10 MHz CC (Band 12)	FDD	Region 2
UL: 20 MHz DL: 20 MHz	10 MHz CC (Band 2) + 10 MHz CC (Band 5)	FDD	Region 2
UL: 20 MHz DL: 20 MHz	10 MHz CC (Band 4) + 10 MHz CC (Band 5)	FDD	Region 2
UL: 20 MHz DL: 20 MHz	10 MHz CC (Band 4) + 10 MHz CC (Band 12)	FDD	Region 2

UL: 20 MHz, DL: 20 MHz	10 MHz CC (Band 1) + 10 MHz CC (Band 19)	FDD	Region 3
UL: 20 MHz DL: 20 MHz	10 MHz CC (Band 18) + 10 MHz CC (Band 11)	FDD	Region 3
UL: 20 MHz DL: 20 MHz	10 MHz CC (Band 18) + 10 MHz CC (Band 1)	FDD	Region 3
UL: 15 MHz DL: 15 MHz	5 MHz CC (Band 1) + 10MHz CC (Band 5/8)	FDD	Region 3
UL: 20 MHz DL: 20 MHz	10 MHz CC (Band 1) + 10 MHz CC (Band 5/8)	FDD	Region 3
UL: 30 MHz DL: 30 MHz	20 MHz CC (Band 1) + 10 MHz CC (Band 5/8)	FDD	Region 3
UL: 15 MHz DL: 15 MHz	5 MHz CC (Band 3) + 10MHz CC (Band 5/8)	FDD	Region 3
UL: 20 MHz DL: 20 MHz	10 MHz CC (Band 3) + 10 MHz CC (Band 5/8)	FDD	Region 3
UL: 30 MHz DL: 30 MHz	20 MHz CC (Band 3) + 10 MHz CC (Band 5/8)	FDD	Region 3
UL: 10 MHz DL: 10 MHz	5 MHz CC (Band 18) + 5 MHz CC (Band 2)	FDD	Region 2

NOTE 2: Some operators prefer not to document Release 11 scenarios now (or setting priority), as they see a need to await the outcome of spectrum auctions and regional spectrum allocation before deciding which carrier aggregation scenarios are needed.

Table 3: Operator proposed CA scenarios (High band + High band) combination view

Transmission bandwidth	Number of LTE-A component carriers	Duplex mode	Region
UL: 20 MHz DL: 20 MHz	10 MHz CC (Band 1) + 10 MHz CC (Band 3)	FDD	Region 1
UL: 30 MHz DL: 30 MHz	10 MHz CC (Band 1) + 20 MHz CC (Band 7)	FDD	Region 1
UL: 30 MHz DL: 30 MHz	10 MHz CC (Band 3) + 20 MHz CC (Band 7)	FDD	Region 1
UL: 40 MHz DL: 40 MHz	20 MHz CC (Band 7) + 20 MHz CC (Band 22)	FDD	Region 1
UL: 40 MHz DL: 40 MHz	20 MHz CC (Band 7) + 20 MHz CC (Band 3)	FDD	Region 1
UL: 10 MHz DL: 10 MHz	(Beyond R10) 5 MHz CC (Band 4) + 5 MHz CC (Band 2)	FDD	Region 2
UL: 20 MHz DL: 20 MHz	10 MHz CC (Band 2) + 10 MHz CC (Band 4)	FDD	Region 2
UL: 20 MHz DL: 20 MHz	10 MHz CC (Band 11) + 10 MHz CC (Band 1)	FDD	Region 3
UL/DL: 40MHz	20 MHz CC (Band 38) + 20 MHz CC (Band 40)	TDD	Region 3
UL/DL:	Beyond R10	TDD	Region 3

65MHz	15MHz CC(Band 34) + 50MHz (Band 40)		

NOTE 3: Some operators prefer not to document Release 11 scenarios now (or setting priority), as they see a need to await the outcome of spectrum auctions and regional spectrum allocation before deciding which carrier aggregation scenarios are needed.

Table 4: Operator proposed CA scenarios - (Low band + Low band) combination view

Transmission bandwidth	Number of LTE-A component carriers	Duplex mode	Region
UL: 20 MHz DL: 20 MHz	10 MHz CC (Band 13) + 10 MHz CC (Band 12)	FDD	Region 2
UL: 20 MHz DL: 20 MHz	10 MHz CC (Band 5) + 10 MHz CC (Band 12)	FDD	Region 2

NOTE 4: Some operators prefer not to document Release 11 scenarios now (or setting priority), as they see a need to await the outcome of spectrum auctions and regional spectrum allocation before deciding which carrier aggregation scenarios are needed.

Table 5: Operator proposed CA scenarios - (Three bands) combination view

Transmission bandwidth	Number of LTE-A component carriers	Duplex mode	Region
UL: 40 MHz DL: 40 MHz	10 MHz CC (Band 1) + 10 MHz CC (Band 3) + 20 MHz CC (Band 7)	FDD	Region 1
UL: 30 MHz DL: 30 MHz	10 MHz CC (Band 13) + 10 MHz CC (Band 12) + 10 MHz (Band 4)	FDD	Region 2
UL: 30 MHz DL: 30 MHz	10 MHz CC (Band 18) + 10 MHz CC (Band 11) + 10 MHz (Band 1)	FDD	Region 3
UL/DL: 85 MHz	(Beyond R10) 20MHz(band 39) + 15MHz(band 34) + 50MHz(band 40)	TDD	Region 3

NOTE 5: Some companies feel that three band scenarios should be postponed to Release 11 and later.

NOTE 6: Some operators prefer not to document Release 11 scenarios now (or setting priority), as they see a need to await the outcome of spectrum auctions and regional spectrum allocation before deciding which carrier aggregation scenarios are needed.

A.3.1 Additional insertion losses

For inter-band CA when combining two bands there will be additional insertion loss due to extra components needed (diplexer/quadplexer/switches). The figure below gives an overview on how this additional insertion losses can be dealt with.

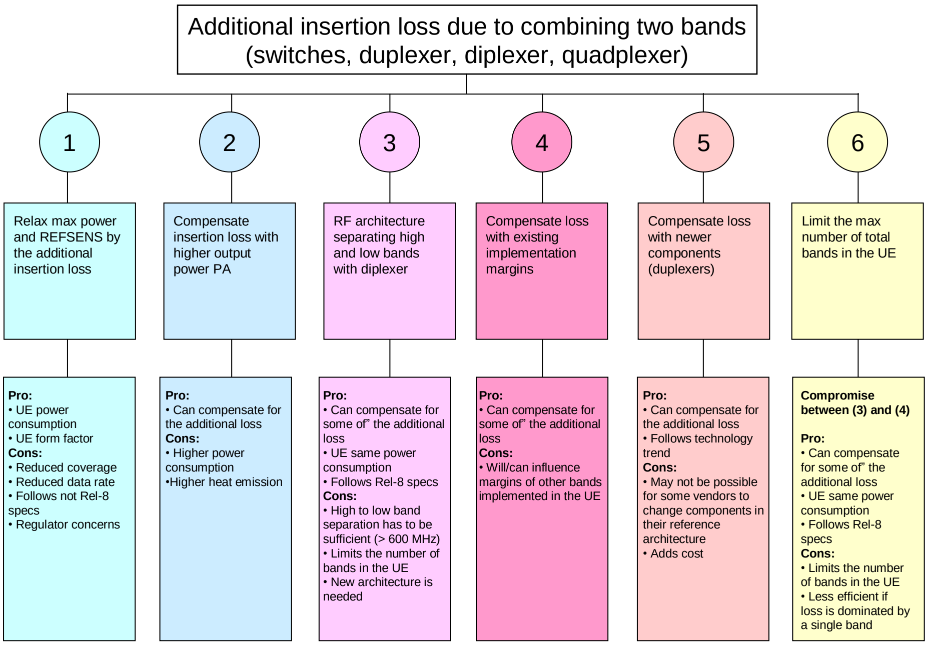


Figure A.3.1-1: How to deal with additional insertion losses

A.4 Intra - band Contiguous CA

As discussed so far, this seems more likely in bands already allocated, or allocated prior to LTE-A deployments, where mergers or new auctions or regional spectrum allocations lead to operators having non-contiguous spectrum. From a Release 10 time frame point of view, however, it would be premature to start the RAN4 work on this scenario and it would be acceptable to delay it in later release. Band scenarios after Release 10 are presented in Table 6.

(Proposed band scenarios)

- ***FDD: None***
- ***TDD: None***

Table 6: Operator proposed CA scenarios – Intra-band non-contiguous

Transmission bandwidth	Number of LTE-A component carriers	Duplex mode	Region
UL: 40 MHz DL: 40 MHz	20 MHz CC (Band 7) + 20 MHz CC (Band 7)	FDD	Region 1
UL: 10 MHz DL: 10 MHz	5 MHz CC (Band 2) + 5 MHz CC (Band 2)	FDD	Region 2

Annex B:
Changes to TS 36.101

The baseline requirement are; TS 36.101 v10.3.0 (2011-06) sections 2, 3, 4, 5, 6, and 7.

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] ITU-R Recommendation SM.329-10, "Unwanted emissions in the spurious domain"

[3] ITU-R Recommendation M.1545: "Measurement uncertainty as it applies to test limits for the terrestrial component of International Mobile Telecommunications-2000".

[4] 3GPP TS 36.211: "Physical Channels and Modulation".

[5] 3GPP TS 36.212: "Multiplexing and channel coding".

[6] 3GPP TS 36.213: "Physical layer procedures".

[7] 3GPP TS 36.331: " Requirements for support of radio resource management ".

[8] 3GPP TS 36.307: " Requirements on User Equipments (UEs) supporting a release-independent frequency band".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply in the case of a single component carrier. 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.

Aggregated Transmission Bandwidth Configuration: The number of resource block allocated within the aggregated channel bandwidth.

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.

Channel edge: The lowest and highest frequency of the carrier, separated by the channel bandwidth.

Channel bandwidth: The RF bandwidth supporting a single E-UTRA RF carrier with the transmission bandwidth configured in the uplink or downlink of a cell. The channel bandwidth is measured in MHz and is used as a reference for transmitter and receiver RF requirements.

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.

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.

3.2 Symbols

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

$BW_{Channel}$	Channel bandwidth
$BW_{Channel\_CA}$	Aggregated channel bandwidth, expressed in MHz.
BW_{GB}	Virtual guard band to facilitate transmitter (receiver) filtering above / below edge CCs.
E_{RS}	Transmitted energy per RE for reference symbols during the useful part of the symbol, i.e. excluding the cyclic prefix, (average power normalized to the subcarrier spacing) at the eNode B transmit antenna connector
$\hat{E}_s$	The received energy per RE of the wanted signal during the useful part of the symbol, i.e. excluding the cyclic prefix, averaged across the allocated RB(s) (average power within the allocated RB(s), divided by the number of RE within this allocation, and normalized to the subcarrier spacing) at the UE antenna connector
F	Frequency
$F_{Interferer}$ (offset)	Frequency offset of the interferer
$F_{Interferer}$	Frequency of the interferer
F_C	Frequency of the carrier centre frequency
F_{CA_low}	The centre frequency of the *lowest carrier*, expressed in MHz.
F_{CA_high}	The centre frequency of the *highest carrier*, expressed in MHz.
F_{DL_low}	The lowest frequency of the downlink operating band
F_{DL_high}	The highest frequency of the downlink operating band
F_{UL_low}	The lowest frequency of the uplink operating band
F_{UL_high}	The highest frequency of the uplink operating band
F_{edge_low}	The *lower edge* of aggregated channel bandwidth, expressed in MHz.
F_{edge_high}	The *higher edge* of aggregated channel bandwidth, expressed in MHz.
F_{offset}	Frequency offset from F_{C_high} to the *higher edge* or F_{C_low} to the *lower edge*.
I_o	The power spectral density of the total input signal (power averaged over the useful part of the symbols within the transmission bandwidth configuration, divided by the total number of RE for this configuration and normalised to the subcarrier spacing) at the UE antenna connector, including the own-cell downlink signal
I_{or}	The total transmitted power spectral density of the own-cell downlink signal (power averaged over the useful part of the symbols within the transmission bandwidth configuration, divided by the total number of RE for this configuration and normalised to the subcarrier spacing) at the eNode B transmit antenna connector
$\hat{I}_{or}$	The total received power spectral density of the own-cell downlink signal (power averaged over the useful part of the symbols within the transmission bandwidth configuration, divided by the total number of RE for this configuration and normalised to the subcarrier spacing) at the UE antenna connector

I_{ot} The received power spectral density of the total noise and interference for a certain RE (average power obtained within the RE and normalized to the subcarrier spacing) as measured at the UE antenna connector
N_{cp} Cyclic prefix length
N_{DL} Downlink EARFCN
N_{oc} The power spectral density of a white noise source (average power per RE normalised to the subcarrier spacing), simulating interference from cells that are not defined in a test procedure, as measured at the UE antenna connector $N_{Offs\text{-}DL}$ Offset used for calculating downlink EARFCN
$N_{Offs\text{-}UL}$ Offset used for calculating uplink EARFCN
N_{otx} The power spectral density of a white noise source (average power per RE normalised to the subcarrier spacing) simulating eNode B transmitter impairments as measured at the eNode B transmit antenna connector
N_{RB} Transmission bandwidth configuration, expressed in units of resource blocks
N_{RB_agg} Aggregated Transmission Bandwidth Configuration The number of the aggregated RBs within the fully allocated Aggregated Channel bandwidth.
N_{RB_alloc} Total number of simultaneously transmitted resource blocks in Aggregated Channel Bandwidth configuration.
N_{UL} Uplink EARFCN
Rav Minimum average throughput per RB
P_{CMAX} The configured maximum UE output power.
$P_{CMAX,c}$ The configured maximum UE output power for serving cell *c*.
P_{EMAX} Maximum allowed UE output power signalled by higher layers. Same as IE *P-Max*, defined in [7].
$P_{EMAX,c}$ Maximum allowed UE output power signalled by higher layers for serving cell *c*. Same as IE *P-Max*, defined in [7].
$P_{Interferer}$ Modulated mean power of the interferer
$P_{PowerClass}$ $P_{PowerClass}$ is the nominal UE power (i.e., no tolerance).
P_{UMAX} The measured configured maximum UE output power.
ΔF_{OOB} Δ Frequency of Out Of Band emission.
$\Delta R_{IB,c}$ Allowed reference sensitivity relaxation due to support for inter-band CA operation, for serving cell *c*.
$\Delta T_{IB,c}$ Allowed maximum configured output power relaxation due to support for inter-band CA operation, for serving cell *c*.
ΔT_C Allowed operating band edge transmission power relaxation.
$\Delta T_{C,c}$ Allowed operating band edge transmission power relaxation for serving cell *c*.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

ACLR Adjacent Channel Leakage Ratio
ACS Adjacent Channel Selectivity
A-MPR Additional Maximum Power Reduction
AWGN Additive White Gaussian Noise
BS Base Station
CA Carrier Aggregation
CA_X CA for band X where X is the applicable E-UTRA operating band
CA_X-Y CA for band X and Band Y where X and Y are the applicable E-UTRA operating band
CC Component Carriers
CPE Customer Premise Equipment
CPE_X Customer Premise Equipment for E-UTRA operating band X
CW Continuous Wave
DL Downlink
eDL-MIMO Down Link Multiple Antenna transmission
EARFCN E-UTRA Absolute Radio Frequency Channel Number
EPRE Energy Per Resource Element
E-UTRA Evolved UMTS Terrestrial Radio Access
EUTRAN Evolved UMTS Terrestrial Radio Access Network
EVM Error Vector Magnitude
FDD Frequency Division Duplex

FRC	Fixed Reference Channel
HD-FDD	Half- Duplex FDD
MCS	Modulation and Coding Scheme
MOP	Maximum Output Power
MPR	Maximum Power Reduction
MSD	Maximum Sensitivity Degradation
OCNG	OFDMA Channel Noise Generator
OFDMA	Orthogonal Frequency Division Multiple Access
OOB	Out-of-band
PA	Power Amplifier
P-MPR	Power Management Maximum Power Reduction
PSS	Primary Synchronization Signal
PSS_RA	PSS-to-RS EPRE ratio for the channel PSS
RE	Resource Element
REFSENS	Reference Sensitivity power level
r.m.s	Root Mean Square
SNR	Signal-to-Noise Ratio
SSS	Secondary Synchronization Signal
SSS_RA	SSS-to-RS EPRE ratio for the channel SSS
TDD	Time Division Duplex
UE	User Equipment
UL	Uplink
UL-MIMO	Up Link Multiple Antenna transmission
UMTS	Universal Mobile Telecommunications System
UTRA	UMTS Terrestrial Radio Access
UTRAN	UMTS Terrestrial Radio Access Network
xCH_RA	xCH-to-RS EPRE ratio for the channel xCH in all transmitted OFDM symbols not containing RS
xCH_RB	xCH-to-RS EPRE ratio for the channel xCH in all transmitted OFDM symbols containing RS

4 General

4.1 Relationship between minimum requirements and test requirements

The Minimum Requirements given in this specification make no allowance for measurement uncertainty. The test specification TS 36.521-1 Annex F defines Test Tolerances. These Test Tolerances are individually calculated for each test. The Test Tolerances are used to relax the Minimum Requirements in this specification to create Test Requirements.

The measurement results returned by the Test System are compared - without any modification - against the Test Requirements as defined by the shared risk principle.

The Shared Risk principle is defined in ITU-R M.1545 [3].

4.2 Applicability of minimum requirements

a) In this specification the Minimum Requirements are specified as general requirements and additional requirements. Where the Requirement is specified as a general requirement, the requirement is mandated to be met in all scenarios

b) For specific scenarios for which an additional requirement is specified, in addition to meeting the general requirement, the UE is mandated to meet the additional requirements.

c) The reference sensitivity power levels defined in subclause 7.3 are valid for the specified reference measurement channels.

d) Note: Receiver sensitivity degradation may occur when:

1) the UE simultaneously transmits and receives with bandwidth allocations less than the transmission bandwidth configuration (see Figure 5.6-1), and

2) any part of the downlink transmission bandwidth is within an uplink transmission bandwidth from the downlink center subcarrier.

e) The spurious emissions power requirements are for the long term average of the power. For the purpose of reducing measurement uncertainty it is acceptable to average the measured power over a period of time sufficient to reduce the uncertainty due to the statistical nature of the signal.

4.3 Void

4.3A Applicability of minimum requirements (CA, UL-MIMO, eDL-MIMO, CPE)

The requirements which are specific to CA, UL-MA, DL_MA and CPE are specified as suffix A, B, C, D where;

a) Suffix A additional requirements need to support CA

b) Suffix B additional requirements need to support UL-MIMO

c) Suffix C additional requirements need to support CPE

d) Suffix D additional requirements need to support eDL-MIMO

A terminal which supports the above features needs to meet both the general requirements and the additional requirement applicable to the additional sub-clause (suffix A, B, C and D). Where there is a difference in requirement between the general requirements and the additional sub-clause requirements (suffix A, B, C and D), the tighter requirements are applicable unless stated otherwise in the additional sub-clause.

A terminal which support more than one feature (CA, UL-MIMO, eDL-MIMO and CPE) shall meet all of the separate corresponding requirements.

4.4 RF requirements in later releases

The standardisation of new frequency bands may be independent of a release. However, in order to implement a UE that conforms to a particular release but supports a band of operation that is specified in a later release, it is necessary to specify some extra requirements. TS 36.307 [8] specifies requirements on UEs supporting a frequency band that is independent of release.

NOTE: For terminals conforming to the 3GPP release of the present document, some RF requirements in later releases may be mandatory independent of whether the UE supports the bands specified in later releases or not. The set of requirements from later releases that is also mandatory for UEs conforming to the 3GPP release of the present document is determined by regional regulation.

5 Operating bands and channel arrangement

5.1 General

The channel arrangements presented in this clause are based on the operating bands and channel bandwidths defined in the present release of specifications.

NOTE: Other operating bands and channel bandwidths may be considered in future releases.

5.2 Void

5.3 Void

5.4 Void

5.5 Operating bands

E-UTRA is designed to operate in the operating bands defined in Table 5.5-1.

Table 5.5-1 E-UTRA operating bands

E-UTRA Operating Band	Uplink (UL) operating band BS receive UE transmit			Downlink (DL) operating band BS transmit UE receive			Duplex Mode
	F_{UL_low}	–	F_{UL_high}	F_{DL_low}	–	F_{DL_high}	
1	1920 MHz	–	1980 MHz	2110 MHz	–	2170 MHz	FDD
2	1850 MHz	–	1910 MHz	1930 MHz	–	1990 MHz	FDD
3	1710 MHz	–	1785 MHz	1805 MHz	–	1880 MHz	FDD
4	1710 MHz	–	1755 MHz	2110 MHz	–	2155 MHz	FDD
5	824 MHz	–	849 MHz	869 MHz	–	894MHz	FDD
6[1]	830 MHz	–	840 MHz	875 MHz	–	885 MHz	FDD
7	2500 MHz	–	2570 MHz	2620 MHz	–	2690 MHz	FDD
8	880 MHz	–	915 MHz	925 MHz	–	960 MHz	FDD
9	1749.9 MHz	–	1784.9 MHz	1844.9 MHz	–	1879.9 MHz	FDD
10	1710 MHz	–	1770 MHz	2110 MHz	–	2170 MHz	FDD
11	1427.9 MHz	–	1447.9 MHz	1475.9 MHz	–	1495.9 MHz	FDD
12	699 MHz	–	716 MHz	729 MHz	–	746 MHz	FDD
13	777 MHz	–	787 MHz	746 MHz	–	756 MHz	FDD
14	788 MHz	–	798 MHz	758 MHz	–	768 MHz	FDD
15	Reserved			Reserved			FDD
16	Reserved			Reserved			FDD
17	704 MHz	–	716 MHz	734 MHz	–	746 MHz	FDD
18	815 MHz	–	830 MHz	860 MHz	–	875 MHz	FDD
19	830 MHz	–	845 MHz	875 MHz	–	890 MHz	FDD
20	832 MHz	–	862 MHz	791 MHz	–	821 MHz	FDD
21	1447.9 MHz	–	1462.9 MHz	1495.9 MHz	–	1510.9 MHz	FDD
...							
23	2000 MHz	–	2020 MHz	2180 MHz	–	2200 MHz	FDD
24	1626.5 MHz	–	1660.5 MHz	1525 MHz	–	1559 MHz	FDD
25	1850 MHz	–	1915 MHz	1930 MHz	–	1995 MHz	FDD
...							
33	1900 MHz	–	1920 MHz	1900 MHz	–	1920 MHz	TDD
34	2010 MHz	–	2025 MHz	2010 MHz	–	2025 MHz	TDD
35	1850 MHz	–	1910 MHz	1850 MHz	–	1910 MHz	TDD
36	1930 MHz	–	1990 MHz	1930 MHz	–	1990 MHz	TDD
37	1910 MHz	–	1930 MHz	1910 MHz	–	1930 MHz	TDD
38	2570 MHz	–	2620 MHz	2570 MHz	–	2620 MHz	TDD
39	1880 MHz	–	1920 MHz	1880 MHz	–	1920 MHz	TDD
40	2300 MHz	–	2400 MHz	2300 MHz	–	2400 MHz	TDD
41	2496 MHz		2690 MHz	2496 MHz		2690 MHz	TDD
42	3400 MHz	–	3600 MHz	3400 MHz	–	3600 MHz	TDD
43	3600 MHz	–	3800 MHz	3600 MHz	–	3800 MHz	TDD
Note 1: Band 6 is not applicable							

5.5A Operating bands for CA

E-UTRA carrier aggregation is designed to operate in the operating bands defined in Tables 5.5A-1 and 5.5A-2.

Table 5.5A-1: Intra band CA operating bands

E-UTRA CA Band	E-UTRA Band	Uplink (UL) operating band BS receive / UE transmit			Downlink (DL) operating band BS transmit / UE receive			Duplex Mode
		FUL_low	–	FUL_high	FDL_low	–	FDL_high	
CA_1	1	1920 MHz	–	1980 MHz	2110 MHz	–	2170 MHz	FDD
CA_40	40	2300 MHz	–	2400 MHz	2300 MHz	–	2400 MHz	TDD

Table 5.5A-2: Inter band CA operating bands

E-UTRA CA Band	E-UTRA Band	Uplink (UL) operating band BS receive / UE transmit			Downlink (DL) operating band BS transmit / UE receive			Duplex Mode
		FUL_low	–	FUL_high	FDL_low	–	FDL_high	

CA_1-5	1	1920 MHz	–	1980 MHz	2110 MHz	–	2170 MHz	FDD
	5	824 MHz	–	849 MHz	869 MHz	–	894 MHz	

5.5B Operating bands for UL-MIMO

E-UTRA UL-MIMO in Rel-10 is designed to operate in the operating bands defined in Tables 5.5B-1.

Table 5.5B-1: UL-MIMO operating bands

E-UTRA Operating Band	Uplink (UL) operating band BS receive/ UE transmit			Downlink (DL) operating band BS transmit / UE receive			Duplex Mode
	F_{UL_low}	–	F_{UL_high}	F_{DL_low}	–	F_{DL_high}	
1	1920 MHz	–	1980 MHz	2110 MHz	–	2170 MHz	FDD
2	1850 MHz	–	1910 MHz	1930 MHz	–	1990 MHz	FDD
3	1710 MHz	–	1785 MHz	1805 MHz	–	1880 MHz	FDD
4	1710 MHz	–	1755 MHz	2110 MHz	–	2155 MHz	FDD
5	824 MHz	–	849 MHz	869 MHz	–	894MHz	FDD
6[1]	830 MHz	–	840 MHz	875 MHz	–	885 MHz	FDD
7	2500 MHz	–	2570 MHz	2620 MHz	–	2690 MHz	FDD
8	880 MHz	–	915 MHz	925 MHz	–	960 MHz	FDD
9	1749.9 MHz	–	1784.9 MHz	1844.9 MHz	–	1879.9 MHz	FDD
10	1710 MHz	–	1770 MHz	2110 MHz	–	2170 MHz	FDD
11	1427.9 MHz	–	1447.9 MHz	1475.9 MHz	–	1495.9 MHz	FDD
12	699 MHz	–	716 MHz	729 MHz	–	746 MHz	FDD
13	777 MHz	–	787 MHz	746 MHz	–	756 MHz	FDD
14	788 MHz	–	798 MHz	758 MHz	–	768 MHz	FDD
15	Reserved			Reserved			FDD
16	Reserved			Reserved			FDD
17	704 MHz	–	716 MHz	734 MHz	–	746 MHz	FDD
18	815 MHz	–	830 MHz	860 MHz	–	875 MHz	FDD
19	830 MHz	–	845 MHz	875 MHz	–	890 MHz	FDD
20	832 MHz	–	862 MHz	791 MHz	–	821 MHz	FDD
21	1447.9 MHz	–	1462.9 MHz	1495.9 MHz	–	1510.9 MHz	FDD
...							
23	2000 MHz	–	2020 MHz	2180 MHz	–	2200 MHz	FDD
24	1626.5 MHz	–	1660.5 MHz	1525 MHz	–	1559 MHz	FDD
25	1850 MHz	–	1915 MHz	1930 MHz	–	1995 MHz	FDD
...							
33	1900 MHz	–	1920 MHz	1900 MHz	–	1920 MHz	TDD
34	2010 MHz	–	2025 MHz	2010 MHz	–	2025 MHz	TDD
35	1850 MHz	–	1910 MHz	1850 MHz	–	1910 MHz	TDD
36	1930 MHz	–	1990 MHz	1930 MHz	–	1990 MHz	TDD
37	1910 MHz	–	1930 MHz	1910 MHz	–	1930 MHz	TDD
38	2570 MHz	–	2620 MHz	2570 MHz	–	2620 MHz	TDD
39	1880 MHz	–	1920 MHz	1880 MHz	–	1920 MHz	TDD
40	2300 MHz	–	2400 MHz	2300 MHz	–	2400 MHz	TDD
41	2496 MHz		2690 MHz	2496 MHz		2690 MHz	TDD
42	3400 MHz	–	3600 MHz	3400 MHz	–	3600 MHz	TDD
43	3600 MHz	–	3800 MHz	3600 MHz	–	3800 MHz	TDD
Note 1: Band 6 is not applicable							

5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1: Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

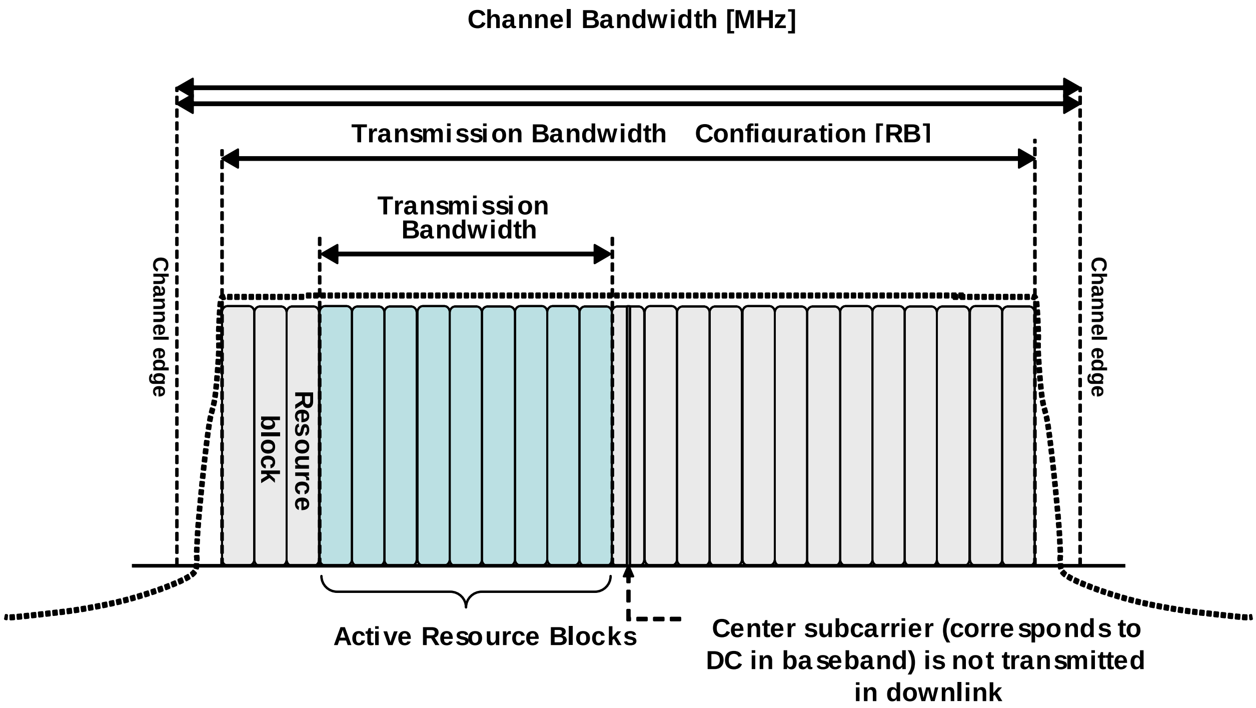


Figure 5.6-1: Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

5.6.1 Channel bandwidths per operating band

a) The requirements in this specification apply to the combination of channel bandwidths and operating bands shown in Table 5.6.1-1. The transmission bandwidth configuration in Table 5.6.1-1 shall be supported for each of the specified channel bandwidths. The same (symmetrical) channel bandwidth is specified for both the TX and RX path.

Table 5.6.1-1: E-UTRA channel bandwidth

E-UTRA band / channel bandwidth						
E-UTRA Band	***1.4 MHz***	***3 MHz***	***5 MHz***	***10 MHz***	***15 MHz***	***20 MHz***
1			Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes[1]	Yes[1]
3	Yes	Yes	Yes	Yes	Yes[1]	Yes[1]
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes[1]		
6			Yes	Yes[1]		
7			Yes	Yes	Yes	Yes[1]
8	Yes	Yes	Yes	Yes[1]		
9			Yes	Yes	Yes[1]	Yes[1]
10			Yes	Yes	Yes	Yes
11			Yes	Yes[1]		
12	Yes	Yes	Yes[1]	Yes[1]		
13			Yes[1]	Yes[1]		
14			Yes[1]	Yes[1]		
...						
17			Yes[1]	Yes[1]		
18			Yes	Yes[1]	Yes[1]	
19			Yes	Yes[1]	Yes[1]	
20			Yes	Yes[1]	Yes[1]	Yes[1]
21			Yes	Yes[1]	Yes[1]	
...						
23	Yes	Yes	Yes	Yes		
24			Yes	Yes		
25	Yes	Yes	Yes	Yes	Yes[1]	Yes[1]
...						
33			Yes	Yes	Yes	Yes
34			Yes	Yes	Yes	
35	Yes	Yes	Yes	Yes	Yes	Yes
36	Yes	Yes	Yes	Yes	Yes	Yes
37			Yes	Yes	Yes	Yes
38			Yes	Yes	Yes	Yes
39			Yes	Yes	Yes	Yes
40			Yes	Yes	Yes	Yes
41			Yes	Yes	Yes	Yes
42			Yes	Yes	Yes	Yes
43			Yes	Yes	Yes	Yes
NOTE 1: bandwidth for which a relaxation of the specified UE receiver sensitivity requirement (Clause 7.3) is allowed.						

b) The use of different (asymmetrical) channel bandwidth for the TX and RX is not precluded and is intended to form part of a later release.

5.6A Channel bandwidth for CA

For intra-band contiguously aggregated component carriers *Aggregated Channel Bandwidth*, *Aggregated Transmission Bandwidth Configuration* and *Guard Bands* are defined as follows, see Figure 5.6A-1.

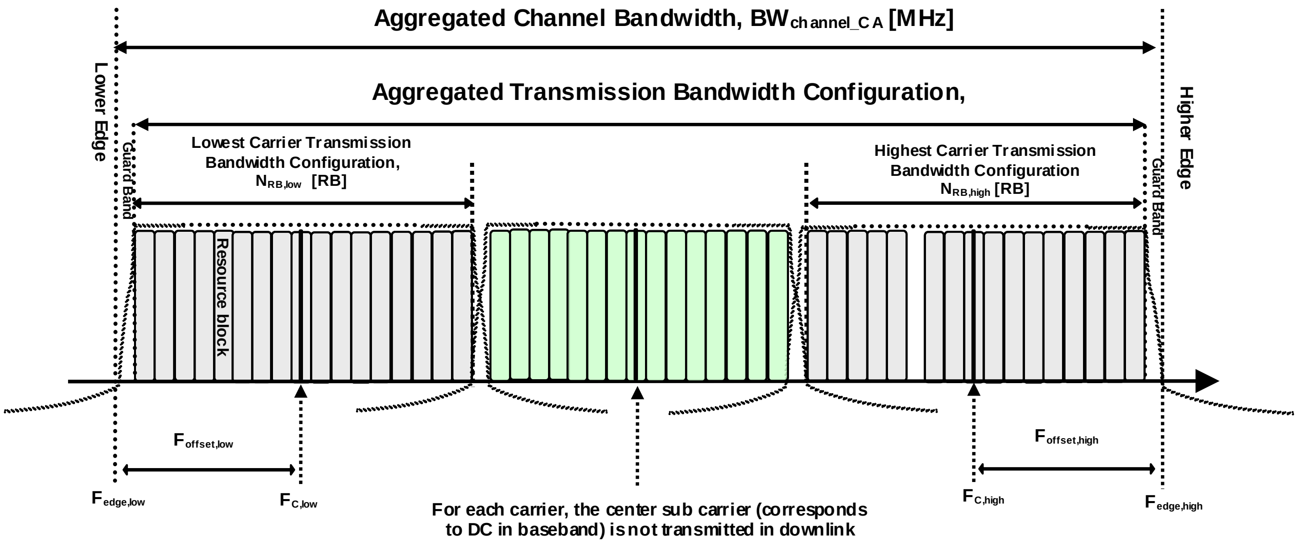


Figure 5.6A-1. Definition of Aggregated Channel Bandwidth and Aggregated Channel Bandwidth Edges

The *aggregated channel bandwidth*, $BW_{Channel\_CA}$, is defined as

$$BW_{Channel\_CA} = F_{edge,high} - F_{edge,low} \quad [MHz].$$

The lower bandwidth edge $F_{edge,low}$ and the upper bandwidth edge $F_{edge,high}$ of the aggregated channel bandwidth are used as frequency reference points for transmitter and receiver requirements and are defined by

$$F_{edge,low} = F_{C,low} - F_{offset,low}$$

$$F_{edge,high} = F_{C,high} + F_{offset,high}$$

The lower and upper frequency offsets depend on the transmission bandwidth configurations of the lowest and highest assigned edge component carrier and are defined as

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

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

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, respectively. BW_{GB} denotes the *Nominal Guard Band* and is defined in Table 5.6A-1, and the factor 0.18 is the PRB bandwidth in MHz.

NOTE: The values of $BW_{Channel\_CA}$ for UE and BS are the same if the lowest and the highest component carriers are identical.

Aggregated Transmission Bandwidth Configuration is the number of the aggregated RBs within the fully allocated Aggregated Channel bandwidth and is defined per CA Bandwidth Class (Table 5.6A-1).

Table 5.6A-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	$N_{RB,agg} \leq 100$	1	$0.05BW_{Channel(1)}$
B	$N_{RB,agg} \leq 100$	2	FFS
C	$100 < N_{RB,agg} \leq 200$	2	$0.05\ max(BW_{Channel(1)},BW_{Channel(2)})$
D	$200 < N_{RB,agg} \leq [300]$	FFS	FFS
E	$[300] < N_{RB,agg} \leq [400]$	FFS	FFS
F	$[400] < N_{RB,agg} \leq [500]$	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.			

The channel spacing between centre frequencies of contiguously aggregated component carriers is defined in clause 5.7A.1.

5.6A.1 Channel bandwidths per operating band for CA

The requirements in this specification apply to the combination of CA bandwidth class and CA operating bands shown in Table 5.6A.1-1.

Indexing letter in CA configuration acronym refers to supported CA bandwidth class. In case no CA bandwidth class is labelled acronym refers to all specified combinations of CA bandwidth class and CA operating band. CA configuration refers to a combination of CA operating band and CA bandwidth class supported by a UE.

DL component carrier combinations for a given CA operating band shall be symmetrical in relation to channel centre unless stated otherwise in table 5.6A.1-1 or 5.6A.1-2.

Table 5.6A.1-1: Supported E-UTRA bandwidths per CA configuration for intra-band contiguous CA

CA operating band / channel bandwidth							
E-UTRA CA Configuration	**E-UTRA Bands**	**1.4 MHz**	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
CA_1C	1					Yes	Yes
CA_40C[1]	40				Yes	Yes	Yes
NOTE 1: Combinations of component carriers with unequal channel bandwidth should be considered. The maximum number of CCs for combination is two.							

Table 5.6A.1-2: Supported E-UTRA bandwidths per CA configuration for inter-band CA

CA operating / channel bandwidth							
E-UTRA CA Configuration	**E-UTRA Bands**	**1.4 MHz**	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
CA_1A-5A	1				Yes		
	5				Yes		

5.6B Channel bandwidth for UL-MIMO

5.6B.1 Channel bandwidths per operating band for UL-MIMO

For UL-MIMO, the channel bandwidths specified in Table 5.6.1-1 in TS36.101 apply for the UL-MIMO operating bands in the present document.

5.7 Channel arrangement

5.7.1 Channel spacing

The spacing between carriers will depend on the deployment scenario, the size of the frequency block available and the channel bandwidths. The nominal channel spacing between two adjacent E-UTRA carriers is defined as following:

$$\text{Nominal Channel spacing} = (BW_{Channel(1)} + BW_{Channel(2)})/2$$

where $BW_{Channel(1)}$ and $BW_{Channel(2)}$ are the channel bandwidths of the two respective E-UTRA carriers. The channel spacing can be adjusted to optimize performance in a particular deployment scenario.

5.7.1A Channel spacing for intra-band contiguous CA

For CA Bandwidth Class C, the nominal channel spacing between two adjacent E-UTRA component carriers is defined as the following:

$$\text{Nominal channel spacing} = \left\lfloor \frac{BW_{Channel(1)} + BW_{Channel(2)} - 0.1\left|BW_{Channel(1)} - BW_{Channel(2)}\right|}{0.6} \right\rfloor 0.3 \quad [\text{MHz}]$$

where $BW_{Channel(1)}$ and $BW_{Channel(2)}$ are the channel bandwidths of the two respective E-UTRA component carriers according to Table 5.6-1 with values in MHz. The channel spacing for intra-band contiguous carrier aggregation can be adjusted to any multiple of 300 kHz less than the nominal channel spacing to optimize performance in a particular deployment scenario.

5.7.2 Channel raster

The channel raster is 100 kHz for all bands, which means that the carrier centre frequency must be an integer multiple of 100 kHz.

5.7.2A Channel raster for CA

For LTE-A same channel raster as in E-UTRA Rel-9 is applied. Hence the channel raster is 100 kHz for all bands, which means that the carrier centre frequency must be an integer multiple of 100 kHz.

5.7.3 Carrier frequency and EARFCN

The carrier frequency in the uplink and downlink is designated by the E-UTRA Absolute Radio Frequency Channel Number (EARFCN) in the range 0 - 65535. The relation between EARFCN and the carrier frequency in MHz for the downlink is given by the following equation, where F_{DL_low} and $N_{Offs\text{-}DL}$ are given in table 5.7.3-1 and N_{DL} is the downlink EARFCN.

$$F_{DL} = F_{DL\_low} + 0.1(N_{DL} - N_{Offs\text{-}DL})$$

The relation between EARFCN and the carrier frequency in MHz for the uplink is given by the following equation where F_{UL_low} and $N_{Offs\text{-}UL}$ are given in table 5.7.3-1 and N_{UL} is the uplink EARFCN.

$$F_{UL} = F_{UL\_low} + 0.1(N_{UL} - N_{Offs\text{-}UL})$$

Table 5.7.3-1: E-UTRA channel numbers

E-UTRA Operating Band	Downlink			Uplink		
	F_{DL_low} (MHz)	$N_{Offs\text{-}DL}$	Range of N_{DL}	F_{UL_low}(MHz)	$N_{Offs\text{-}UL}$	Range of N_{UL}
1	2110	0	0 – 599	1920	18000	18000 – 18599
2	1930	600	600 – 1199	1850	18600	18600 – 19199
3	1805	1200	1200 – 1949	1710	19200	19200 – 19949
4	2110	1950	1950 – 2399	1710	19950	19950 – 20399
5	869	2400	2400 – 2649	824	20400	20400 – 20649
6	875	2650	2650 – 2749	830	20650	20650 – 20749
7	2620	2750	2750 – 3449	2500	20750	20750 – 21449
8	925	3450	3450 – 3799	880	21450	21450 – 21799
9	1844.9	3800	3800 – 4149	1749.9	21800	21800 – 22149
10	2110	4150	4150 – 4749	1710	22150	22150 – 22749
11	1475.9	4750	4750 – 4949	1427.9	22750	22750 – 22949
12	729	5010	5010 - 5179	699	23010	23010 - 23179
13	746	5180	5180 – 5279	777	23180	23180 – 23279
14	758	5280	5280 – 5379	788	23280	23280 – 23379

…						
17	734	5730	5730 – 5849	704	23730	23730 - 23849
18	860	5850	5850 – 5999	815	23850	23850 – 23999
19	875	6000	6000 – 6149	830	24000	24000 – 24149
20	791	6150	6150 – 6449	832	24150	24150 – 24449
21	1495.9	6450	6450 – 6599	1447.9	24450	24450 – 24599
…						
23	2180	7500	7500 – 7699	2000	25500	25500 – 25699
24	1525	7700	7700 - 8039	1626.5	25700	25700 – 26039
25	1930	8040	8040 - 8689	1850	26040	26040 - 26689
…						
33	1900	36000	36000 – 36199	1900	36000	36000 – 36199
34	2010	36200	36200 – 36349	2010	36200	36200 – 36349
35	1850	36350	36350 – 36949	1850	36350	36350 – 36949
36	1930	36950	36950 – 37549	1930	36950	36950 – 37549
37	1910	37550	37550 – 37749	1910	37550	37550 – 37749
38	2570	37750	37750 – 38249	2570	37750	37750 – 38249
39	1880	38250	38250 – 38649	1880	38250	38250 – 38649
40	2300	38650	38650 – 39649	2300	38650	38650 – 39649
41	2496	39650	39650 – 41589	2496	39650	39650 – 41589
42	3400	41590	41590 – 43589	3400	41590	41590 – 43589
43	3600	43590	43590 – 45589	3600	43590	43590 – 45589
NOTE: The channel numbers that designate carrier frequencies so close to the operating band edges that the carrier extends beyond the operating band edge shall not be used. This implies that the first 7, 15, 25, 50, 75 and 100 channel numbers at the lower operating band edge and the last 6, 14, 24, 49, 74 and 99 channel numbers at the upper operating band edge shall not be used for channel bandwidths of 1.4, 3, 5, 10, 15 and 20 MHz respectively.						

5.7.4 TX–RX frequency separation

a) The default E-UTRA TX channel (carrier centre frequency) to RX channel (carrier centre frequency) separation is specified in Table 5.7.4-1 for the TX and RX channel bandwidths defined in Table 5.6.1-1

Table 5.7.4-1: Default UE TX-RX frequency separation

E-UTRA Operating **Band**	**TX - RX carrier centre frequency separation**
1	190 MHz
2	80 MHz.
3	95 MHz.
4	400 MHz
5	45 MHz
6	45 MHz
7	120 MHz
8	45 MHz
9	95 MHz
10	400 MHz
11	48 MHz
12	30 MHz
13	-31 MHz
14	-30 MHz
17	30 MHz
18	45 MHz
19	45 MHz
20	-41 MHz
21	48 MHz
…	
23	180 MHz
24	-101.5 MHz
25	80 MHz

b) The use of other TX channel to RX channel carrier centre frequency separation is not precluded and is intended to form part of a later release.

c) The range E-UTRA TX channel (carrier centre frequency) to RX channel (carrier centre frequency) separations for operating bands supporting variable duplex FDD is specified in Table 5.7.4-2.

Table 5.7.4-2: TX-RX frequency separation for operating bands supporting variable duplex FDD

E-UTRA Operating Band	**TX - RX carrier centre frequency separation**	
	Allowed offset	**Separation**
23	-10 MHz	170 MHz
	+10 MHz	190 MHz

5.7.4A TX–RX frequency separation for CA

For CA, the same TX-RX frequency separation as specified in Table 5.7.4-1 is applied to PCC and SCC, respectively.

6 Transmitter characteristics

6.1 General

Unless otherwise stated, the transmitter characteristics are specified at the antenna connector of the UE with a single or multiple transmit antenna(s). For UE with integral antenna only, a reference antenna with a gain of 0 dBi is assumed.

6.2 Transmit power

6.2.1 Void

6.2.2 UE Maximum Output Power

The following UE Power Classes define the maximum output power for any transmission bandwidth within the channel bandwidth for non CA configuration and UL-MIMO unless otherwise stated. The period of measurement shall be at least one sub frame (1ms).

Table 6.2.2-1: UE Power Class

EUTRA band	Class 1 (dBm)	Tolerance (dB)	Class 2 (dBm)	Tolerance (dB)	Class 3 (dBm)	Tolerance (dB)	Class 4 (dBm)	Tolerance (dB)
1					23	±2		
2					23	±2[2]		
3					23	±2[2]		
4					23	±2		
5					23	±2		
6					23	±2		
7					23	±2[2]		
8					23	±2[2]		
9					23	±2		
10					23	±2		
11					23	±2		
12					23	±2[2]		
13					23	±2		
14					23	±2		
17					23	±2		
18					23	±2		
19					23	±2		
20					23	±2[2]		
21					23	±2		
…								
23					23	±2		
24					23	±2		
25					23	±2[2]		
…								
33					23	±2		
34					23	±2		
35					23	±2		
36					23	±2		
37					23	±2		
38					23	±2		
39					23	±2		
40					23	±2		
41					23	±2		
42					23	±2		
43					23	±2		

Note 1: The above tolerances are applicable for UE(s) that support up to 4 E-UTRA operating bands. For UE(s) that support 5 or more E-UTRA bands the maximum output power is expected to decrease with each additional band and is FFS

Note 2: For transmission bandwidths (Figure 5.6-1) confined within F_{UL_low} and F_{UL_low} + 4 MHz or F_{UL_high} – 4 MHz and F_{UL_high}, the maximum output power requirement is relaxed by reducing the lower tolerance limit by 1.5 dB

Note 3: For the UE which supports both Band 11 and Band 21 operating frequencies, the tolerance is FFS.

Note 4: $P_{PowerClass}$ is the maximum UE power specified without taking into account the tolerance

6.2.2A UE Maximum Output Power for intra-band contiguous CA

The following UE Power Classes define the maximum output power for any transmission bandwidth within the aggregated channel bandwidth.

The maximum output power is measured as the sum of the maximum output power at each UE antenna connector. The period of measurement shall be at least one sub frame (1ms).

For CA Bandwidth Class A, the requirements in Clause 6.2.2 apply. For CA Bandwidth Class C, the maximum output power is specified in Table 6.2.2A-1.

Table 6.2.2A-1: CA UE Power Class

EUTRA band	Class 1 (dBm)	Tolerance (dB)	Class 2 (dBm)	Tolerance (dB)	Class 3 (dBm)	Tolerance (dB)	Class 4 (dBm)	Tolerance (dB)
CA_1C					23	+2/-2		
CA_40C					23	+2/[-2]		

Note 1: The above tolerances are applicable for UE(s) that support up to 4 E-UTRA operating bands. For UE(s) that support 5 or more E-UTRA bands the maximum output power is expected to decrease with each additional band and is FFS

Note 2: For transmission bandwidths (Figure 5.6-1) confined within F_{UL_low} and F_{UL_low} + 4 MHz or F_{UL_high} – 4 MHz and F_{UL_high}, the maximum output power requirement is relaxed by reducing the lower tolerance limit by 1.5 dB

Note 3: $P_{PowerClass}$ is the maximum UE power specified without taking into account the tolerance

Note 4: For intra-band contiguous carrier aggregation the maximum power requirement should apply to the total transmitted power over all component carriers (per UE).

6.2.2B UE Maximum Output Power for UL-MIMO

For UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the maximum output power for any transmission bandwidth within the channel bandwidth is specified in Table 6.2.2B-1 with the UL-MIMO configurations specified in Table 6.2.2B-2. The maximum output power is measured as the sum of the maximum output power at each UE antenna connector. The period of measurement shall be at least one sub frame (1ms).

Table 6.2.2B-1: UE Power Class for UL-MIMO in closed loop spatial multiplexing scheme

EUTRA band	Class 1 (dBm)	Tolerance (dB)	Class 2 (dBm)	Tolerance (dB)	Class 3 (dBm)	Tolerance (dB)	Class 4 (dBm)	Tolerance (dB)
1					23	+2/-3		
3					23	+2/-3[2]		
7					23	+2/-3[2]		
40					23	+2/-3		

Note 1: The above tolerances are applicable for UE(s) that support up to 4 E-UTRA operating bands. For UE(s) that support 5 or more E-UTRA bands the maximum output power is expected to decrease with each additional band and is FFS

Note 2: For transmission bandwidths (Figure 5.6-1) confined within F_{UL_low} and F_{UL_low} + 4 MHz or F_{UL_high} – 4 MHz and F_{UL_high}, the maximum output power requirement is relaxed by reducing the lower tolerance limit by 1.5 dB

Note 3: For the UE which supports both Band 11 and Band 21 operating frequencies, the tolerance is FFS.

Note 4: $P_{PowerClass}$ is the maximum UE power specified without taking into account the tolerance

Table 6.2.2B-2: UL-MIMO configuration in closed-loop spatial multiplexing scheme

Transmission mode	DCI format	Codebook Index
Mode 2	DCI format 4	Codebook index 0

For single-antenna port scheme, that is, Transmission Mode 1 or Transmission Mode 2 with DCI Format 0 configured, the requirements in Clause 6.2.2 apply.

6.2.3 UE Maximum Output power for modulation / channel bandwidth

For UE Power Class 3, the allowed Maximum Power Reduction (MPR) for the maximum output power in Table 6.2.2-1due to higher order modulation and transmit bandwidth configuration (resource blocks) is specified in Table 6.2.3-1.

Table 6.2.3-1: Maximum Power Reduction (MPR) for Power Class 3

Modulation	Channel bandwidth / Transmission bandwidth (RB)						MPR (dB)
	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz	
QPSK	> 5	> 4	> 8	> 12	> 16	> 18	≤ 1
16 QAM	≤ 5	≤ 4	≤ 8	≤ 12	≤ 16	≤ 18	≤ 1
16 QAM	> 5	> 4	> 8	> 12	> 16	> 18	≤ 2

For the UE maximum output power modified by MPR, the power limits specified in sub-clause 6.2.5 apply.

6.2.3A UE Maximum Output power for modulation / channel bandwidth for CA

For intra-band contiguous CA Bandwidth Class A (Table 5.6A-1), the requirements in Clause 6.2.3 apply.

For CA Bandwidth Class C the allowed Maximum Power Reduction (MPR) for the maximum output power in Table 6.2.2A-1due to higher order modulation and contiguously aggregated transmit bandwidth configuration (resource blocks) is specified in Table 6.2.3A-1.

Table 6.2.3A-1: Maximum Power Reduction (MPR) for Power Class 3

Modulation	CA bandwidth Class C			MPR (dB)
	50 RB / 100 RB	75 RB / 75 RB	100 RB / 100 RB	
QPSK	> 12 and ≤ 50	> 16 and ≤ 75	> 18 and ≤ 100	≤ 1
QPSK	> 50	> 75	> 100	≤ 2
16 QAM	≤ 12	≤ 16	≤ 18	≤ 1
16 QAM	> 12 and ≤ 50	> 16 and ≤ 75	> 18 and ≤ 100	≤ 2
16 QAM	> 50	> 75	> 100	≤ 3

For intra-band contiguous CA Bandwidth Class C the allowed Maximum Power Reduction (MPR) for the maximum output power in Table 6.2.2A-1 due to multi cluster transmission is specified as follows

$$\text{MPR} = \text{CEIL}\{M_{A,}\ 0.5\}$$

Where M_A is defined as follows

$$\begin{aligned} M_A &= 7.2, && 0 < A \le 0.05 \\ &= 8 - 16A, && 0.05 < A \le 0.25 \\ &= 4.83 - 3.33A, && 0.25 < A \le 0.4 \\ &= 3.83 - 0.83A, && 0.4 < A \le 1 \end{aligned}$$

Where A = N_{RB_alloc} / $N_{RB\_agg.}$

For the UE maximum output power modified by MPR, the power limits specified in sub-clause 6.2.5A apply.

6.2.3B UE Maximum Output power for modulation / channel bandwidth for UL-MIMO

For UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the allowed Maximum Power Reduction (MPR) for the maximum output power in Table 6.2.2B-1 is specified in Table 6.2.3-1 with UL-MIMO configurations defined in Table 6.2.2B-2. The maximum output power is measured as the sum of the maximum output power at each UE antenna connector.

For the UE maximum output power modified by MPR, the power limits specified in sub-clause 6.2.5B apply.

6.2.4 UE Maximum Output Power with additional requirements

Additional ACLR and spectrum emission requirements can be signalled by the network to indicate that the UE shall also meet additional requirements in a specific deployment scenario. To meet these additional requirements, Additional Maximum Power Reduction A-MPR is allowed for the output power as specified in Table 6.2.2-1. Unless stated otherwise, an A-MPR of 0 dB shall be used.

For UE Power Class 3 the specific requirements and identified sub-clauses are specified in Table 6.2.4-1 along with the allowed A-MPR values that may be used to meet these requirements. The allowed A-MPR values specified below in Table 6.2.4.-1 and 6.2.4-2 are in addition to the allowed MPR requirements specified in clause 6.2.3.

Table 6.2.4-1: Additional Maximum Power Reduction (A-MPR)

Network Signalling value	Requirements (sub-clause)	E-UTRA Band	Channel bandwidth (MHz)	Resources Blocks (N_{RB})	A-MPR (dB)
NS_01	6.6.2.1.1	Table 5.5-1	1.4, 3, 5, 10, 15, 20	Table 5.6-1	NA
NS_03	6.6.2.2.1	2, 4,10, 23, 25, 35, 36	3	>5	≤ 1
			5	>6	≤ 1
			10	>6	≤ 1
			15	>8	≤ 1
			20	>10	≤ 1
NS_04	6.6.2.2.2	41	5	>6	≤ 1
			10, 15, 20	See Table 6.2.4-4	
NS_05	6.6.3.3.1	1	10,15,20	≥ 50	≤ 1
NS_06	6.6.2.2.3	12, 13, 14, 17	1.4, 3, 5, 10	Table 5.6-1	n/a
NS_07	6.6.2.2.3 6.6.3.3.2	13	10	Table 6.2.4-2	Table 6.2.4-2
NS_08	6.6.3.3.3	19	10, 15	> 44	≤ 3
NS_09	6.6.3.3.4	21	10, 15	> 40	≤ 1
				> 55	≤ 2
NS_10		20	15, 20	Table 6.2.4-3	Table 6.2.4-3
NS_11	6.6.2.2.1	23[1]	1.4, 3, 5, 10	Table 6.2.4-5	Table 6.2.4-5
..					
NS_32	-	-	-	-	-
Note 1: Applies to the lower block of Band 23, i.e. a carrier placed in the 2000-2010 MHz region.					

Table 6.2.4-2: A-MPR for "NS_07"

Parameters	Region A		Region B		Region C
RB_start[1]	0 - 12		13 – 18	19 – 42	43 – 49
L_CRB[2] [RBs]	6-8	1 to 5 and 9-50	≥8	≥18	≤2
A-MPR [dB]	≤ 8	≤ 12	≤ 12	≤ 6	≤ 3

Note
1 RB_start indicates the lowest RB index of transmitted resource blocks
2 L_CRB is the length of a contiguous resource block allocation
3 For intra-subframe frequency hopping between two regions, notes 1 and 2 apply on a per slot basis.
4 For intra-subframe frequency hopping between two regions, the larger A-MPR value of the two regions may be applied for both slots in the subframe.

Table 6.2.4-3: A-MPR for "NS_10"

Channel BW	Parameters	Region A
15	RB_start1	0 – 10
	L_CRB [RBs]	1 -20
	A-MPR [dB]	≤ 2
20	RB_start1	0 – 15
	L_CRB [RBs]	1 -20
	A-MPR [dB]	≤ 5
Note 1 RB_start indicates the lowest RB index of transmitted resource blocks 2 L_CRB is the length of a contiguous resource block allocation 3 For intra-subframe frequency hopping which intersects Region A, notes 1 and 2 apply on a per slot basis 4 For intra-subframe frequency hopping which intersect Region A, the larger A-MPR value may be applied for both slots in the subframe		

Table 6.2.4-4: A-MPR requirements for NS_04 with bandwidth >5MHz

Channel BW	Parameters	Region A	Region B	Region C
10	RB_start[1]	0 – 12	13 – 36	37 – 49
	RB_start[1] + L_CRB[2] [RBs]	n/a[3]	>37	n/a[3]
	A-MPR [dB]	≤3dB	≤2dB	≤3dB
15	RB_start[1]	0 – 18	19 – 55	56 – 74
	RB_start[1] + L_CRB[2] [RBs]	n/a[3]	>56	n/a[3]
	A-MPR [dB]	≤3dB	≤2dB	≤3dB
20	RB_start[1]	0 – 24	25 – 74	75 – 99
	RB_start[1] + L_CRB[2] [RBs]	n/a[3]	>75	n/a[3]
	A-MPR [dB]	≤3dB	≤2dB	≤3dB
Note 1 RB_start indicates the lowest RB index of transmitted resource blocks 2 L_CRB is the length of a contiguous resource block allocation 3 Any RB allocation that starts in Region A or C is allowed the specified A-MPR 4 For intra-subframe frequency hopping which intersects regions, notes 1 and 2 apply on a per slot basis 5 For intra-subframe frequency hopping which intersects regions, the larger A-MPR value may be applied for both slots in the subframe				

Table 6.2.4-5: A-MPR for NS_11

Channel Bandwidth	Parameters				
3	Fc (MHz)	<2004	≥2004		
	L_CRB (RBs)	1-15	>5		
	A-MPR	≤5	≤ 1		
5	Fc (MHz)	<2004	2004 ≤ Fc <2007		≥2007
	L_CRB (RBs)	1-25	1-6 & 15-25	8-12	>6
	A-MPR	≤7	≤ 4	0	≤ 1
10	Fc (MHz)	2005			
	RB_start (RBs)	0-49			
	L_CRB (RBs)	1-50			
	A-MPR	≤ 12			

For the UE maximum output power modified by A-MPR, the power limits specified in subclause 6.2.5 apply.

6.2.4A UE Maximum Output Power with additional requirements for intra-band contiguous CA

<reserved for future use>

6.2.4B UE Maximum Output Power with additional requirements for UL-MIMO

For UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the A-MPR values specified in sub-clause 6.2.4 shall apply to the maximum output power specified in Table 6.2.2B-1 with the UL-MIMO configurations specified in Table 6.2.2B-2. The maximum output power is measured as the sum of the maximum output power at each UE antenna connector. Unless stated otherwise, an A-MPR of 0 dB shall be used.

For the UE maximum output power modified by A-MPR, the power limits specified in sub-clause 6.2.5B apply.

6.2.5 Configured transmitted Power

The UE is allowed to set its configured maximum output power P_{CMAX}. The configured maximum output power P_{CMAX} is set within the following bounds:

$P_{CMAX\_L} \leq P_{CMAX} \leq P_{CMAX\_H}$

Where

- $P_{CMAX\_L} = \text{MIN} \{ P_{EMAX} - \Delta T_C,\ P_{PowerClass} - \text{MAX}(MPR + A\text{-}MPR, P\text{-}MPR) - \Delta T_C\}$
- $P_{CMAX\_H} = \text{MIN} \{P_{EMAX},\ P_{PowerClass}\}$
- P_{EMAX} is the value given to IE *P-Max*, defined in [7]
- $P_{PowerClass}$ is the maximum UE power specified in Table 6.2.2-1 without taking into account the tolerance specified in the Table 6.2.2-1
- MPR and A-MPR are specified in Section 6.2.3 and Section 6.2.4, respectively
- P-MPR is the power management term
- ΔT_C = 1.5 dB when Note 2 in Table 6.2.2-1 applies
- ΔT_C = 0 dB when Note 2 in Table 6.2.2-1 does not apply

The measured configured maximum output power P_{UMAX} shall be within the following bounds:

$P_{CMAX\_L} - T(P_{CMAX\_L}) \leq P_{UMAX} \leq P_{CMAX\_H} + T(P_{CMAX\_H})$

Where $T(P_{CMAX})$ is defined by the tolerance table below and applies to P_{CMAX_L} and P_{CMAX_H} separately

Table 6.2.5-1: P_{CMAX} tolerance

P_{CMAX} (dBm)	Tolerance $T(P_{CMAX})$ (dB)
$21 \leq P_{CMAX} \leq 23$	2.0
$20 \leq P_{CMAX} < 21$	2.5
$19 \leq P_{CMAX} < 20$	3.5
$18 \leq P_{CMAX} < 19$	4.0
$13 \leq P_{CMAX} < 18$	5.0
$8 \leq P_{CMAX} < 13$	6.0
$-40 \leq P_{CMAX} < 8$	7.0

6.2.5A Configured transmitted Power for CA

For carrier aggregation the UE is allowed to set its configured maximum output power $P_{CMAX,c}$ on serving cell c and its total configured maximum output power P_{CMAX}.

The configured maximum output power on serving cell c shall be set within the following bounds:

$$P_{CMAX\_L,c} \leq P_{CMAX,c} \leq P_{CMAX\_H,c}$$

For intra-band contiguous carrier aggregation:

- $P_{CMAX\_L,c} = \text{MIN} \{ P_{EMAX,c} - \Delta T_{C,c}, \; P_{PowerClass} - \text{MAX}(MPR_c + A\text{-}MPR_c, P\text{-}MPR_c) - \Delta T_{C,c} \}$

For inter-band non-contiguous carrier aggregation:

- - $P_{CMAX\_L,c} = \text{MIN} \{ P_{EMAX,c} - \Delta T_{C,c}, \; P_{PowerClass} - \text{MAX}(MPR_c + A\text{-}MPR_c + \Delta T_{IB,c}, P\text{-}MPR_c) - \Delta T_{C,c} \}$
- - $P_{CMAX\_H,c} = \text{MIN} \{P_{EMAX,c}, P_{PowerClass}\}$
- - $P_{EMAX,c}$ is the value given by IE *P-Max* for serving cell c in [7].
- - $P_{PowerClass}$ is the maximum UE power specified in Table 6.2.2-1 without taking into account the tolerance specified in the Table 6.2.2-1.
- $\Delta T_{IB,c}$ is the additional tolerance for serving cell c as specified in Table 6.2.5A-3.

For inter-band CA, MPR_c and $A\text{-}MPR_c$ apply per serving cell c and are specified in Section 6.2.3 and Section 6.2.4, respectively. For intra-band contiguous CA, MPR_c = MPR and $A\text{-}MPR_c$ = A-MPR with MPR and A-MPR specified in Section 6.2.3A and Section 6.2.4A respectively.

- $P\text{-}MPR_c$ accounts for power management for serving cell c. For intra-band CA, there is one power management term for the UE, P-MPR, and $P\text{-}MPR_c$ = P-MPR.
- $\Delta T_{C,c}$ = 1.5 dB when Note 2 in Table 6.2.2-1 applies to the serving cell c.
- $\Delta T_{C,c}$ = 0 dB when Note 2 in Table 6.2.2-1 does not apply to the serving cell c.

For inter-band carrier aggregation with one UL serving cell the total configured maximum output power P_{CMAX} shall be set within the following bounds:

$$P_{CMAX\_L} \leq P_{CMAX} \leq P_{CMAX\_H}$$

where

- $P_{CMAX\_L} = P_{CMAX\_L,c}$
- $P_{CMAX\_H} = P_{CMAX\_H,c}$

The measured maximum output power P_{UMAX} shall be within the following bounds:

$$P_{CMAX\_L} - T(P_{CMAX\_L}) \leq P_{UMAX} \leq P_{CMAX\_H} + T(P_{CMAX\_H})$$

$T(P_{CMAX})$ is defined by the table below and applies to P_{CMAX_L} and P_{CMAX_H} separately.

Table 6.2.5A-1: P_{CMAX} tolerance

P_{CMAX} (dBm)	Tolerance $T(P_{CMAX})$ (dB)
$21 \le P_{CMAX} \le 23$	2.0
$20 \le P_{CMAX} < 21$	[2.5]
$19 \le P_{CMAX} < 20$	[3.5]
$18 \le P_{CMAX} < 19$	[4.0]
$13 \le P_{CMAX} < 18$	[5.0]
$8 \le P_{CMAX} < 13$	[6.0]
$-40 \le P_{CMAX} < 8$	[7.0]

For carrier aggregation with two UL serving cells, the total configured maximum output power P_{CMAX} shall be set within the following bounds:

$$P_{CMAX\_L\_CA} \le P_{CMAX} \le P_{CMAX\_H\_CA}$$

For intra-band contiguous carrier aggregation,

- $P_{CMAX\_L\_CA} = \text{MIN}\{10 \log_{10} \sum p_{EMAX,c} - \Delta T_C, P_{PowerClass} - \text{MAX}(\text{MPR} + \text{A-MPR}, \text{P-MPR}) - \Delta T_C\}$
- $P_{CMAX\_H\_CA} = \text{MIN}\{10 \log_{10} \sum p_{EMAX,c}, P_{PowerClass}\}$

where

- $p_{EMAX,c}$ is the linear value of $P_{EMAX,c}$ which is given by IE *P-Max* for serving cell *c* in [7].
- $P_{PowerClass}$ is the maximum UE power specified in Table 6.2.2A-1 without taking into account the tolerance specified in the Table 6.2.2A-1.
- MPR and A-MPR specified in Section 6.2.3A and Section 6.2.4A respectively.
- P-MPR is the power management term for the UE.
- ΔT_C is the highest value $\Delta T_{C,c}$ among all serving cells *c* in the subframe over both timeslots. $\Delta T_{C,c}$ = 1.5 dB when Note 2 in Table 6.2.2A-1 applies to the serving cell *c*. $\Delta T_{C,c}$ = 0 dB when Note 2 in Table 6.2.2A-1 does not apply to the serving cell *c*.

For inter-band carrier aggregation with up to one serving cell c per operating band:

$P_{CMAX\_L\_CA} = \text{MIN}\{10\log_{10}\sum \text{MIN}[\, p_{EMAX,c}/(\Delta t_{C,c}),\ p_{PowerClass}/(mpr_c \cdot a\text{-}mpr_c \cdot \Delta t_{C,c} \cdot \Delta t_{IB,c}),$

$p_{PowerClass}/(pmpr_c \cdot \Delta t_{C,c})\,], P_{PowerClass}\}$

$P_{CMAX\_H\_CA} = \text{MIN}\{10 \log_{10} \sum p_{EMAX,c}, P_{PowerClass}\}$

where

- $p_{EMAX,c}$ is the linear value of $P_{EMAX,c}$ which is given by IE *P-Max* for serving cell *c* in [7].
- $P_{PowerClass}$ is the maximum UE power specified in Table 6.2.2A-1 without taking into account the tolerance specified in the Table 6.2.2A-1. $p_{PowerClass}$ is the linear value of $P_{PowerClass}$.
- MPR_c and $A\text{-}MPR_c$ apply per serving cell *c* and are specified in Section 6.2.3 and Section 6.2.4, respectively. mpr_c is the linear value of MPR_c. $a\text{-}mpr_c$ is the linear value of $A\text{-}MPR_c$.
- $P\text{-}MPR_c$ accounts for power management for serving cell *c*. $pmpr_c$ is the linear value of $P\text{-}MPR_c$.
- $\Delta t_{C,c}$ = 1.41 when Note 2 in Table 6.2.2-1 applies for a serving cell *c*
- $\Delta t_{C,c}$ = 1 when Note 2 in Table 6.2.2-1 does not apply for a serving cell *c*

- $\Delta t_{IB,c}$ is the linear value of the inter-band relaxation term of the serving cell *c* $\Delta T_{IB,c}$. $\Delta t_{IB,c} = 1$ when no inter-band relaxation is allowed.

The measured maximum output power P_{UMAX} over all serving cells shall be within the following range:

$$P_{CMAX\_L\_CA} - T(P_{CMAX\_L\_CA}) \leq P_{UMAX} \leq P_{CMAX\_H\_CA} + T(P_{CMAX\_H\_CA})$$

$$P_{UMAX} = 10 \log_{10} \sum p_{UMAX,c}$$

where $p_{UMAX,c}$ denotes the measured maximum output power for serving cell *c* expressed in linear scale.

The tolerance $T(P_{CMAX})$ is defined by the table below and applies to $P_{CMAX\_L\_CA}$ and $P_{CMAX\_H\_CA}$ separately.

Table 6.2.5A-2: P_{CMAX} tolerance

P_{CMAX} (dBm)	Tolerance $T(P_{CMAX})$ Intra-band with two active UL serving cells (dB)	Tolerance $T(P_{CMAX})$ Inter-band with two active UL serving cells (dB)
$21 \leq P_{CMAX} \leq 23$	2.0	2.0
$20 \leq P_{CMAX} < 21$	[2.5]	TBD
$19 \leq P_{CMAX} < 20$	[3.5]	TBD
$18 \leq P_{CMAX} < 19$	[4.0]	TBD
$13 \leq P_{CMAX} < 18$	[5.0]	TBD
$8 \leq P_{CMAX} < 13$	[6.0]	TBD
$-40 \leq P_{CMAX} < 8$	[7.0]	TBD

For the UE which supports inter-band CA configuration the $\Delta T_{IB,c}$ is defined for applicable bands in Table 6.2.5A-3.

Table 6.2.5A-3: $\Delta T_{IB,c}$

Inter-band CA Configuration	E-UTRA Band	$\Delta T_{IB,c}$ [dB]
CA_1A-5A	1	0.3
	5	0.3

6.2.5B Configured transmitted power for UL-MIMO

For UE with multiple transmit antenna connectors, the transmitted power is configured per each UE.

The definitions of configured maximum output power P_{CMAX}, the lower bound P_{CMAX_L}, and the higher bound P_{CMAX_H} specified in Section 6.2.5 shall apply to UE with multiple transmit antenna connectors, where

- $P_{PowerClass}$ and ΔT_C are specified in Section 6.2.2B
- MPR is specified in Section 6.2.3B
- A-MPR is specified in Section 6.2.4B

The measured configured maximum output power P_{UMAX} shall be within the following bounds:

$$P_{CMAX\_L} - T_{LOW}(P_{CMAX\_L}) \leq P_{UMAX} \leq P_{CMAX\_H} + T_{HIGH}(P_{CMAX\_H})$$

where $T_{LOW}(P_{CMAX\_L})$ and $T_{HIGH}(P_{CMAX\_H})$ are defined as the tolerance and applies to P_{CMAX_L} and P_{CMAX_H} separately.

For UE with two transmit antenna connectors, the tolerance is specified in Table 6.2.5B-1 with UL-MIMO configurations specified in Table 6.2.2B-2.

Table 6.2.5B-1: P_{CMAX} tolerance in closed-loop spatial multiplexing scheme

P_{CMAX} (dBm)	Tolerance $T_{LOW}(P_{CMAX\_L})$ (dB)	Tolerance $T_{HIGH}(P_{CMAX\_H})$ (dB)
P_{CMAX}=23	3.0	2.0
[22] ≤ P_{CMAX} < [23]	[5.0]	[2.0]
[21] ≤ P_{CMAX} < [22]	[5.0]	[3.0]
[20] ≤ P_{CMAX} < [21]	[6.0]	[4.0]
[16] ≤ P_{CMAX} < [20]	[5.0]	
[11] ≤ P_{CMAX} < [16]	[6.0]	
[-40] ≤ P_{CMAX} < [11]	[7.0]	

6.3 Output power dynamics

6.3.1 (Void)

6.3.2 Minimum output power

The minimum controlled output power of the UE is defined as the broadband transmit power of the UE, i.e. the power in the channel bandwidth for all transmit bandwidth configurations (resource blocks), when the power is set to a minimum value.

6.3.2.1 Minimum requirement

The minimum output power is defined as the mean power in one sub-frame (1ms). The minimum output power shall not exceed the values specified in Table 6.3.2.1-1.

Table 6.3.2.1-1: Minimum output power

	Channel bandwidth / Minimum output power / measurement bandwidth					
	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Minimum output power	-40 dBm					
Measurement bandwidth	1.08 MHz	2.7 MHz	4.5 MHz	9.0 MHz	13.5 MHz	18 MHz

6.3.2A UE Minimum output power for CA

For intra-band contiguous carrier aggregation, the minimum controlled output power of the UE is defined as the transmit power of the UE per component carrier, i.e., the power in the channel bandwidth of each component carrier for all transmit bandwidth configurations (resource blocks), when the power on both component carriers are set to a minimum value.

6.3.2A.1 Minimum requirement for CA

The minimum output power is defined as the mean power in one sub-frame (1ms). The minimum output power shall not exceed the values specified in Table 6.3.2A.1-1.

Table 6.3.2A.1-1: Minimum output power for intra-band contiguous CA UE

	Channel bandwidth / Minimum output power / measurement bandwidth					
	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Minimum output power	-40 dBm					
Measurement bandwidth				9.0 MHz	13.5 MHz	18 MHz

6.3.2B UE Minimum output power for UL-MIMO

For UE with multiple transmit antenna connectors, the minimum controlled output power is defined as the broadband transmit power of the UE at each transmit connector, i.e. the sum of the power in the channel bandwidth for all transmit bandwidth configurations (resource blocks) at each transmit connector, when the UE power is set to a minimum value.

6.3.2B.1 Minimum requirement

For UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the minimum output power is defined as the sum of the mean power at each transmit connector in one sub-frame (1ms). The minimum output power shall not exceed the values specified in Table 6.3.2B.1-1.

Table 6.3.2B.1-1: Minimum output power

	Channel bandwidth / Minimum output power / measurement bandwidth					
	1.4 MHz	**3.0 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
Minimum output power	-40 dBm					
Measurement bandwidth	1.08 MHz	2.7 MHz	4.5 MHz	9.0 MHz	13.5 MHz	18 MHz

6.3.3 Transmit OFF power

Transmit OFF power is defined as the mean power when the transmitter is OFF. The transmitter is considered to be OFF when the UE is not allowed to transmit or during periods when the UE is not transmitting a sub-frame. During DTX and measurements gaps, the UE is not considered to be OFF.

6.3.3.1 Minimum requirement

The transmit OFF power is defined as the mean power in a duration of at least one sub-frame (1ms) excluding any transient periods. The transmit OFF power shall not exceed the values specified in Table 6.3.3.1-1.

Table 6.3.3.1-1: Transmit OFF power

	Channel bandwidth / Transmit OFF power / measurement bandwidth					
	1.4 MHz	**3.0 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
Transmit OFF power	-50 dBm					
Measurement bandwidth	1.08 MHz	2.7 MHz	4.5 MHz	9.0 MHz	13.5 MHz	18 MHz

6.3.3A UE Transmit OFF power for CA

For intra-band contiguous carrier aggregation, transmit OFF power is defined as the mean power per component carrier when the transmitter is OFF on both component carriers. The transmitter is considered to be OFF when the UE is not allowed to transmit or during periods when the UE is not transmitting a sub-frame. During measurements gaps, the UE is not considered to be OFF.

6.3.3A.1 Minimum requirement for CA

The transmit OFF power is defined as the mean power in a duration of at least one sub-frame (1ms) excluding any transient periods. The transmit OFF power shall not exceed the values specified in Table 6.3.3A.1-1.

Table 6.3.3A.1-1: Transmit OFF power for intra-band contiguous CA UE

	Channel bandwidth / Minimum output power / measurement bandwidth					
	1.4 MHz	**3.0 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
Transmit OFF power	-50 dBm					
Measurement bandwidth				9.0 MHz	13.5 MHz	18 MHz

6.3.3B UE Transmit OFF power for UL-MIMO

For UE with multiple transmit antenna connectors, the transmit OFF power is defined as the mean power at each transmit connector when the transmitter is OFF on all transmit connectors. The transmitter is considered to be OFF when the UE is not allowed to transmit or during periods when the UE is not transmitting a sub-frame. During measurements gaps, the UE is not considered to be OFF.

6.3.3B.1 Minimum requirement

The transmit OFF power is defined as the mean power at each transmit connector in a duration of at least one sub-frame (1ms) excluding any transient periods. The transmit OFF power at each transmit connector shall not exceed the values specified in Table 6.3.3B.1-1.

Table 6.3.3B.1-1: Transmit OFF power per antenna port

	Channel bandwidth / Minimum output power / measurement bandwidth					
	1.4 MHz	**3.0 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
Transmit OFF power	-50 dBm					
Measurement bandwidth	1.08 MHz	2.7 MHz	4.5 MHz	9.0 MHz	13.5 MHz	18 MHz

6.3.4 ON/OFF time mask

6.3.4.1 General ON/OFF time mask

The General ON/OFF time mask defines the observation period between Transmit OFF and ON power and between Transmit ON and OFF power. ON/OFF scenarios include; the beginning or end of DTX, measurement gap, contiguous, and non contiguous transmission

The OFF power measurement period is defined in a duration of at least one sub-frame excluding any transient periods. The ON power is defined as the mean power over one sub-frame excluding any transient period.

There are no additional requirements on UE transmit power beyond that which is required in clause 6.2.2 and clause 6.6.2.3

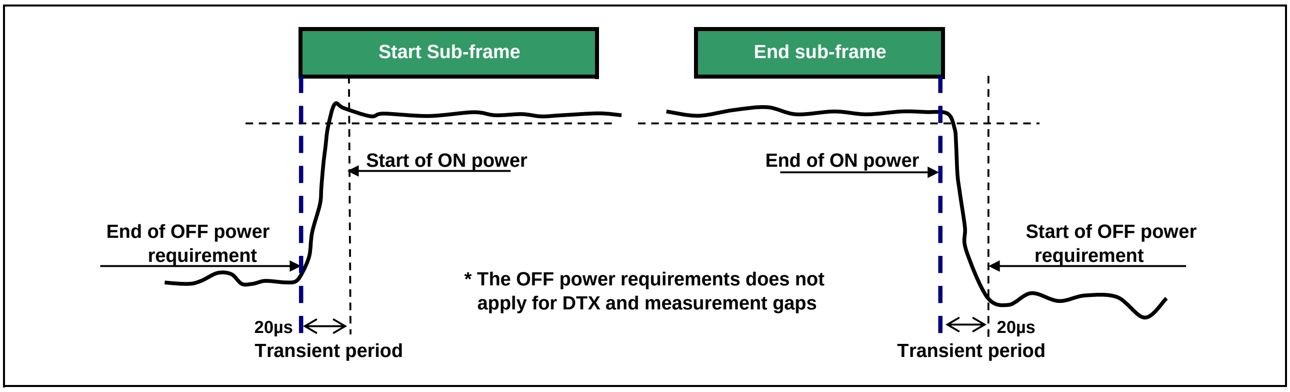


Figure 6.3.4.1-1: General ON/OFF time mask

6.3.4.2 PRACH and SRS time mask

6.3.4.2.1 PRACH time mask

The PRACH ON power is specified as the mean power over the PRACH measurement period excluding any transient periods as shown in Figure 6.3.4.2-1. The measurement period for different PRACH preamble format is specified in Table 6.3.4.2-1.

There are no additional requirements on UE transmit power beyond that which is required in clause 6.2.2 and clause 6.6.2.3

Table 6.3.4.2-1: PRACH ON power measurement period

PRACH preamble format	Measurement period (ms)
0	0.9031
1	1.4844
2	1.8031
3	2.2844
4	0.1479

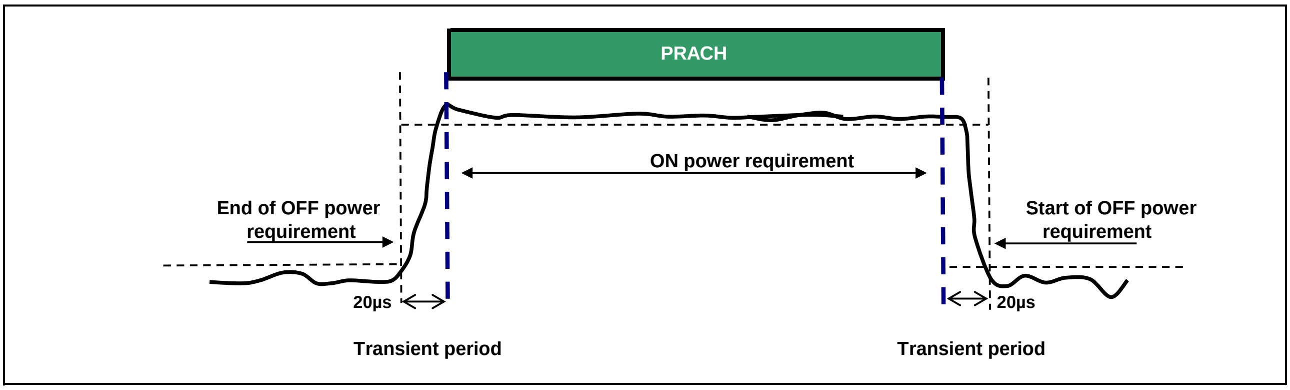


Figure 6.3.4.2-1: PRACH ON/OFF time mask

6.3.4.2.2 SRS time mask

In the case a single SRS transmission, the ON power is defined as the mean power over the symbol duration excluding any transient period. Figure 6.3.4.2.2-1

In the case a dual SRS transmission, the ON power is defined as the mean power for each symbol duration excluding any transient period. Figure 6.3.4.2.2-2

There are no additional requirements on UE transmit power beyond that which is required in clause 6.2.2 and clause 6.6.2.3

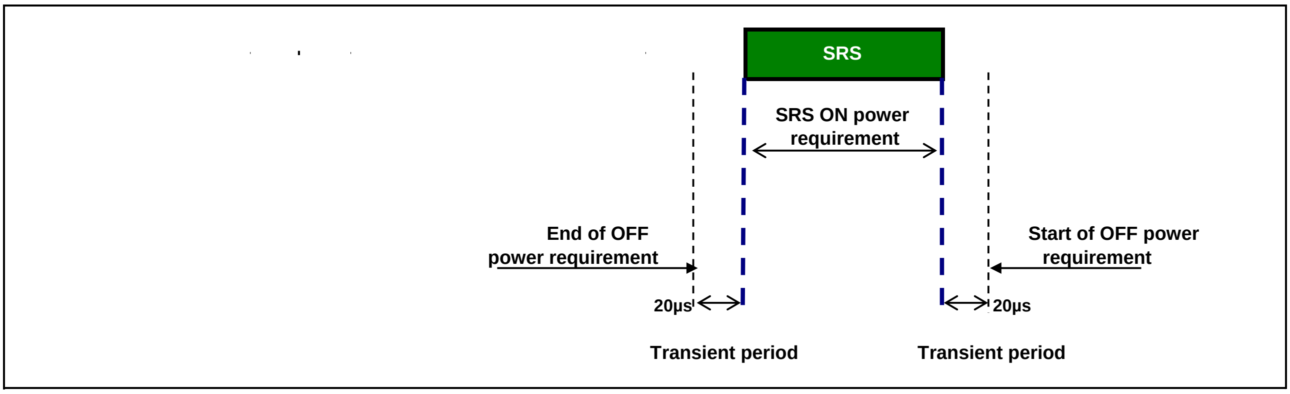


Figure 6.3.4.2.2-1: Single SRS time mask

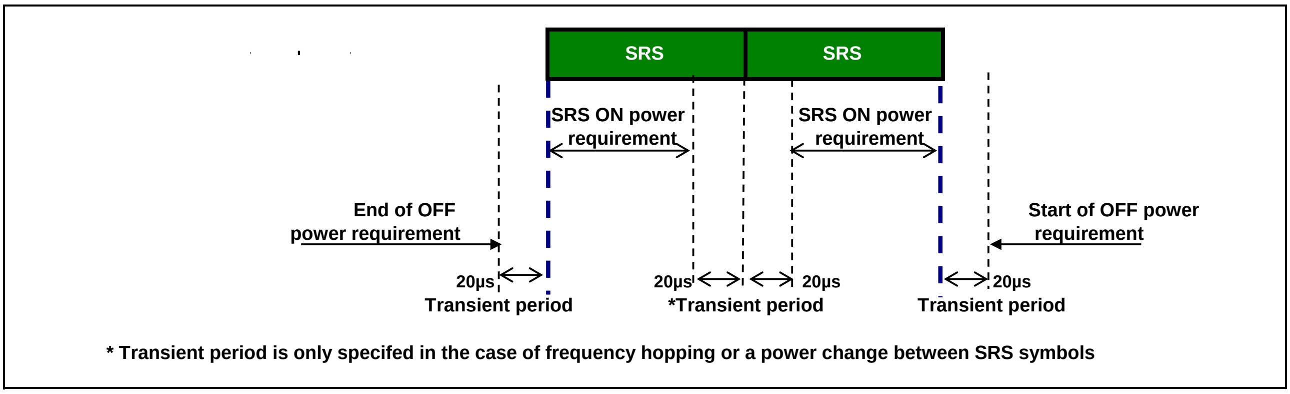


Figure 6.3.4.2.2-2: Dual SRS time mask for the case of UpPTS transmissions

6.3.4.3 Slot / Sub frame boundary time mask

The sub frame boundary time mask defines the observation period between the previous/subsequent sub–frame and the (reference) sub-frame. A transient period at a slot boundary within a sub-frame is only allowed in the case of Intra-sub frame frequency hopping. For the cases when the subframe contains SRS the time masks in subclause 6.3.4.4 apply.

There are no additional requirements on UE transmit power beyond that which is required in clause 6.2.2 and clause 6.6.2.3

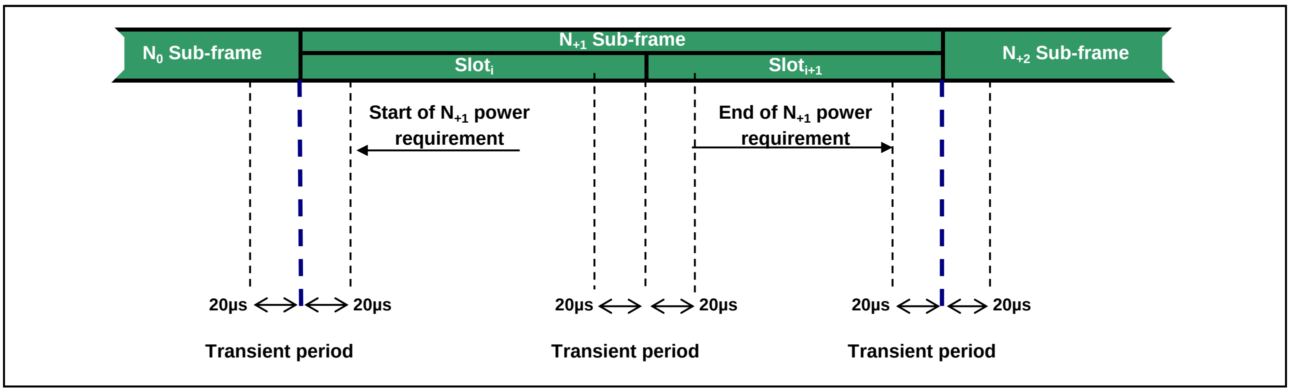


Figure 6.3.4.3-1: Transmission power template

6.3.4.4 PUCCH / PUSCH / SRS time mask

The PUCCH/PUSCH/SRS time mask defines the observation period between sounding reference symbol (SRS) and an adjacent PUSCH/PUCCH symbol and subsequent sub-frame.

There are no additional requirements on UE transmit power beyond that which is required in clause 6.2.2 and clause 6.6.2.3

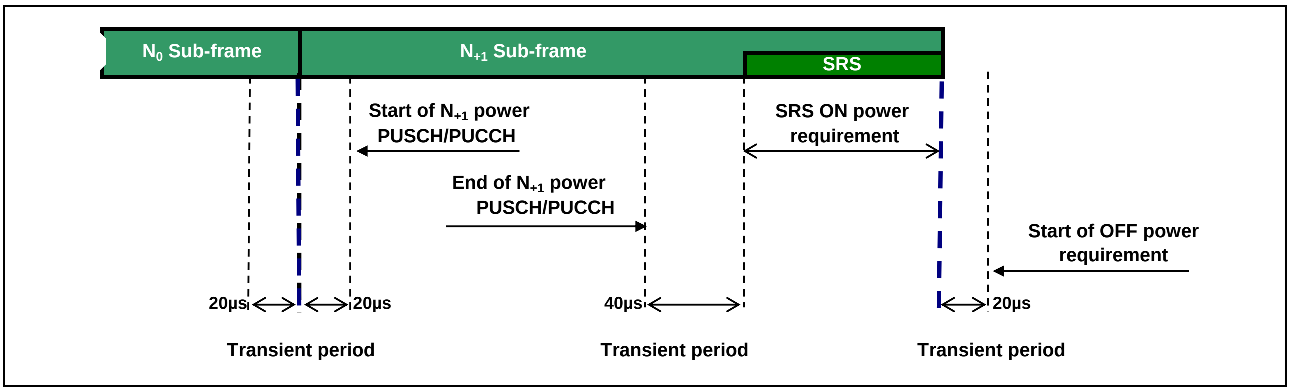


Figure 6.3.4.4-1: PUCCH/PUSCH/SRS time mask when there is a transmission before SRS but not after

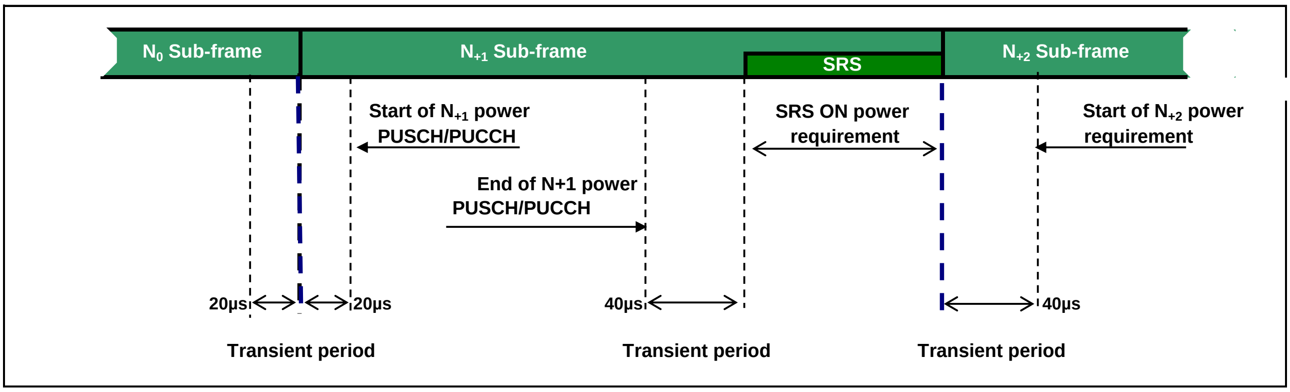


Figure 6.3.4.4-2: PUCCH/PUSCH/SRS time mask when there is transmission before and after SRS

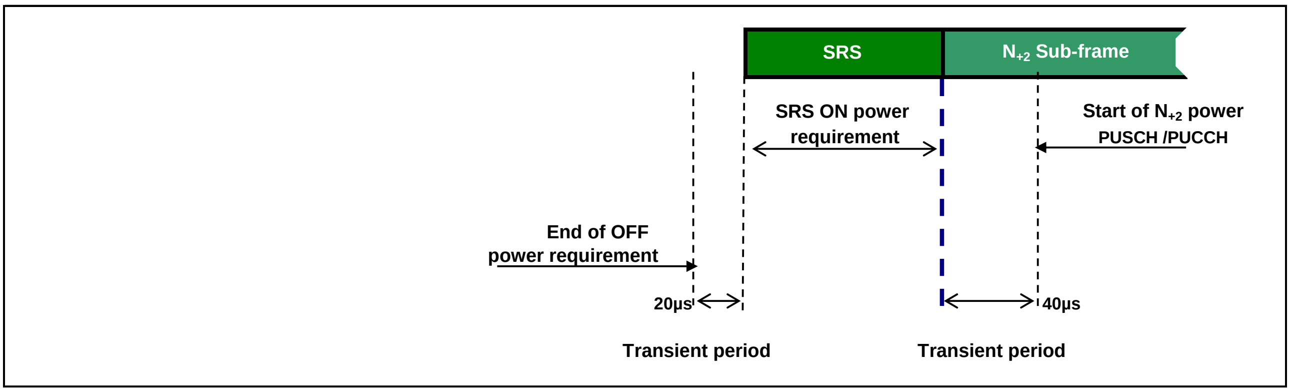


Figure 6.3.4.4-3: PUCCH/PUSCH/SRS time mask when there is a transmission after SRS but not before

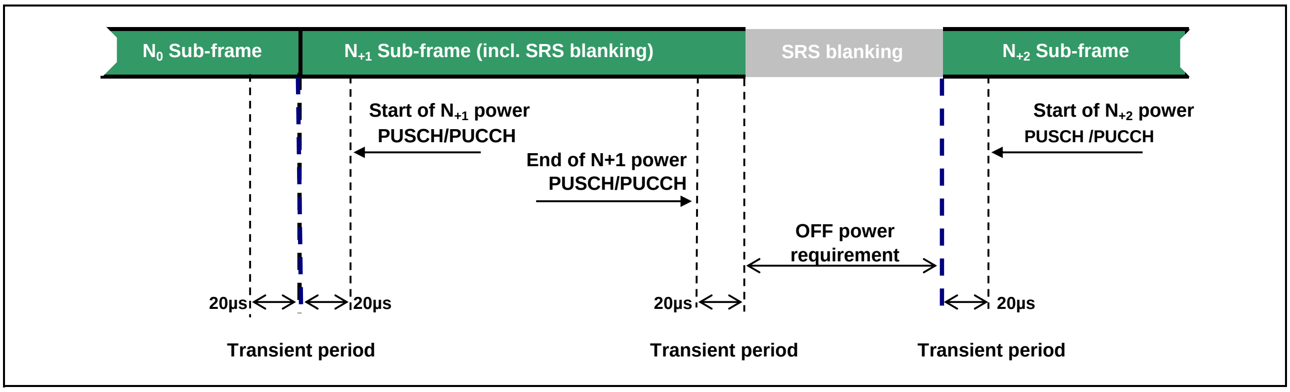


Figure 6.3.4.4-4: SRS time mask when there is FDD SRS blanking

6.3.4A ON/OFF time mask for CA

For intra band contiguous CA, the general output power ON/OFF time mask specified in clause 6.3.4.1 is applicable for each CC during the ON power period and transient period. The OFF period as specified in clause 6.3,4.1 shall only be applicable for each CC when all the CC(s) are OFF.

6.3.4B ON/OFF time mask for UL-MIMO

For UE with multiple transmit antenna connectors, the ON/OFF time mask requirements in section 6.3.4 apply to each transmit antenna connector.

For UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the general ON/OFF time mask requirements specified in Section 6.3.4.1 apply to each transmit antenna connector with the UL-MIMO configurations specified in Table 6.2.2B-2.

6.3.5 Power Control

6.3.5.1 Absolute Power Tolerance

Absolute power tolerance is the ability of the UE transmitter to set its initial output power to a specific value for the first sub-frame at the start of a contiguous transmission or non-contiguous transmission with a transmission gap larger than 20ms. This tolerance includes the channel estimation error (the absolute RSRP accuracy requirement specified in clause 9.1 of TS 36.133)

In the case of a PRACH transmission, the absolute tolerance is specified for the first preamble. The absolute power tolerance includes the channel estimation error (the absolute RSRP accuracy requirement specified in clause 9.1 of TS 36.133).

6.3.5.1.1 Minimum requirements

The minimum requirement for absolute power tolerance is given in Table 6.3.5.1.1-1 over the power range bounded by the Maximum output power as defined in sub-clause 6.2.2 and the Minimum output power as defined in sub-clause 6.3.2.

For operating bands under Note 2 in Table 6.2.2-1, the absolute power tolerance as specified in Table 6.3.5.1.1-1 is relaxed by reducing the lower limit by 1.5 dB when the transmission bandwidth is confined within F_{UL_low} and F_{UL_low} + 4 MHz or F_{UL_high} – 4 MHz and F_{UL_high}.

Table 6.3.5.1.1-1: Absolute power tolerance

Conditions	Tolerance
Normal	± 9.0 dB
Extreme	± 12.0 dB

6.3.5.2 Relative Power tolerance

The relative power tolerance is the ability of the UE transmitter to set its output power in a target sub-frame relatively to the power of the most recently transmitted reference sub-frame if the transmission gap between these sub-frames is ≤ 20 ms.

For PRACH transmission, the relative tolerance is the ability of the UE transmitter to set its output power relatively to the power of the most recently transmitted preamble. The measurement period for the PRACH preamble is specified in Table 6.3.4.2-1.

6.3.5.2.1 Minimum requirements

The requirements specified in Table 6.3.5.2.1-1 apply when the power of the target and reference sub-frames are within the power range bounded by the Minimum output power as defined in subclause 6.3.2 and the measured P_{UMAX} as defined in subclause 6.2.5 (i.e, the actual power as would be measured assuming no measurement error). This power shall be within the power limits specified in subclause 6.2.5.

To account for RF Power amplifier mode changes 2 exceptions are allowed for each of two test patterns. The test patterns are a monotonically increasing power sweep and a monotonically decreasing power sweep over a range bounded by the requirements of minimum power and maximum power specified in clauses 6.3.2 and 6.2.2. For these exceptions the power tolerance limit is a maximum of ±6.0 dB in Table 6.3.5.2.1-1

Table 6.3.5.2.1-1 Relative Power Tolerance for Transmission (normal conditions)

Power step ΔP (Up or down) [dB]	All combinations of PUSCH and PUCCH transitions [dB]	All combinations of PUSCH/PUCCH and SRS transitions between sub-frames [dB]	PRACH [dB]
ΔP < 2	±2.5 (Note 3)	±3.0	±2.5
2 ≤ ΔP < 3	±3.0	±4.0	±3.0
3 ≤ ΔP < 4	±3.5	±5.0	±3.5
4 ≤ ΔP ≤ 10	±4.0	±6.0	±4.0
10 ≤ ΔP < 15	±5.0	±8.0	±5.0
15 ≤ ΔP	±6.0	±9.0	±6.0
Note 1: For extreme conditions an additional ± 2.0 dB relaxation is allowed Note 2: For operating bands under Note 2 in Table 6.2.2-1, the relative power tolerance is relaxed by increasing the upper limit by 1.5 dB if the transmission bandwidth of the reference sub-frames is confined within F_{UL_low} and F_{UL_low} + 4 MHz or F_{UL_high} – 4 MHz and F_{UL_high} and the target sub-frame is not confined within any one of these frequency ranges; if the transmission bandwidth of the target sub-frame is confined within F_{UL_low} and F_{UL_low} + 4 MHz or F_{UL_high} – 4 MHz and F_{UL_high} and the reference sub-frame is not confined within any one of these frequency ranges, then the tolerance is relaxed by reducing the lower limit by 1.5 dB. Note 3: For PUSCH to PUSCH transitions with the allocated resource blocks fixed in frequency and no transmission gaps other than those generated by downlink subframes, DwPTS fields or Guard Periods for TDD: for a power step ΔP ≤ 1 dB, the relative power tolerance for transmission is ±1.0 dB.			

The power step (ΔP) is defined as the difference in the calculated setting of the UE Transmit power between the target and reference sub-frames with the power setting according to Clause 5.1 of [TS 36.213]. The error is the difference between ΔP and the power change measured at the UE antenna port with the power of the cell-specific reference signals kept constant. The error shall be less than the relative power tolerance specified in Table 6.3.5.2.1-1.

For sub-frames not containing an SRS symbol, the power change is defined as the relative power difference between the mean power of the original reference sub-frame and the mean power of the target subframe not including transient durations. The mean power of successive sub-frames shall be calculated according to Figure 6.3.4.3-1 and Figure 6.3.4.1-1 if there is a transmission gap between the reference and target sub-frames.

If at least one of the sub-frames contains an SRS symbol, the power change is defined as the relative power difference between the mean power of the last transmission within the reference sub-frame and the mean power of the first transmission within the target sub-frame not including transient durations. A transmission is defined as PUSCH, PUCCH or an SRS symbol. The mean power of the reference and target sub-frames shall be calculated according to Figures 6.3.4.1-1, 6.3.4.2-1, 6.3.4.4-1, 6.3.4.4-2 and 6.3.4.4-3 for these cases.

6.3.5.3 Aggregate power control tolerance

Aggregate power control tolerance is the ability of a UE to maintain its power in non-contiguous transmission within 21 ms in response to 0 dB TPC commands with respect to the first UE transmission, when the power control parameters specified in TS 36.213 are constant.

6.3.5.3.1 Minimum requirement

The UE shall meet the requirements specified in Table 6.3.5.3.1-1 foraggregate power control over the power range bounded by the minimum output power as defined in subclause 6.3.2 and the maximum output power as defined in subclause 6.2.2.

Table 6.3.5.3.1-1: Aggregate Power Control Tolerance

TPC command	UL channel	Aggregate power tolerance within 21 ms
0 dB	PUCCH	±2.5 dB
0 dB	PUSCH	±3.5 dB
Note: 1. The UE transmission gap is 4 ms. TPC command is transmitted via PDCCH 4 subframes preceding each PUCCH/PUSCH transmission.		

6.3.5A Void

<reserved for future use>

6.3.5B Power Control for UL-MIMO

For UE with multiple transmit antenna connectors, the power control tolerance applies to the sum of output power at each transmit antenna connector.

The power control requirements specified in Section 6.3.5 apply to UE with two transmit antenna connectors with UL-MIMO configurations specified in Table 6.2.2B-2 for closed-loop spatial multiplexing scheme, wherein

- The Maximum output power requirements for UL-MIMO are specified in Section 6.2.2B
- The Minimum output power requirements for UL-MIMO are specified in Section 6.3.2B

6.4 Void

6.5 Transmit signal quality

6.5.1 Frequency error

The UE modulated carrier frequency shall be accurate to within ±0.1 PPM observed over a period of one time slot (0.5 ms) compared to the carrier frequency received from the E-UTRA Node B

6.5.1A Frequency error for Intraband CA

The UE modulated carrier frequencies per band shall be accurate to within ±0.1 PPM observed over a period of one timeslot compared to the carrier frequency of primary component carrier received from the E-UTRA in the corresponding band.

6.5.1B Frequency error for UL-MIMO

For UE(s) with multiple transmit antenna connectors, the UE modulated carrier frequency at each transmit antenna connector shall be accurate to within ±0.1 PPM observed over a period of one time slot (0.5 ms) compared to the carrier frequency received from the E-UTRA Node B.

6.5.2 Transmit modulation quality

Transmit modulation quality defines the modulation quality for expected in-channel RF transmissions from the UE. The transmit modulation quality is specified in terms of:

- Error Vector Magnitude (EVM) for the allocated resource blocks (RBs)
- EVM equalizer spectrum flatness derived from the equalizer coefficients generated by the EVM measurement process
- Carrier leakage (caused by IQ offset)
- In-band emissions for the non-allocated RB

All the parameters defined in clause 6.5.2 are defined using the measurement methodology specified in Annex F.

6.5.2.1 Error Vector Magnitude

The Error Vector Magnitude is a measure of the difference between the reference waveform and the measured waveform. This difference is called the error vector. Before calculating the EVM the measured waveform is corrected by the sample timing offset and RF frequency offset. Then the IQ origin offset shall be removed from the measured waveform before calculating the EVM.

The measured waveform is further modified by selecting the absolute phase and absolute amplitude of the Tx chain. The EVM result is defined after the front-end IDFT as the square root of the ratio of the mean error vector power to the mean reference power expressed as a %.

The basic EVM measurement interval in the time domain is one preamble sequence for the PRACH and is one slot for the PUCCH and PUSCH in the time domain.. When the PUSCH or PUCCH transmission slot is shortened due to multiplexing with SRS, the EVM measurement interval is reduced by one symbol, accordingly. The PUSCH or PUCCH EVM measurement interval is also reduced when the mean power, modulation or allocation between slots is expected to change. In the case of PUSCH transmission, the measurement interval is reduced by a time interval equal to the sum of 5 μs and the applicable exclusion period defined in subclause 6.3.4, adjacent to the boundary where the power change is expected to occur. The PUSCH exclusion period is applied to the signal obtained after the front-end IDFT. In the case of PUCCH transmission with power change, the PUCCH EVM measurement interval is reduced by one symbol adjacent to the boundary where the power change is expected to occur.

6.5.2.1.1 Minimum requirement

The RMS average of the basic EVM measurements for 10 sub-frames excluding any transient period for the average EVM case, and 60 sub-frames excluding any transient period for the reference signal EVM case, for the different modulations schemes shall not exceed the values specified in Table 6.5.2.1.1-1 for the parameters defined in Table 6.5.2.1.1-2. For EVM evaluation purposes, [all PRACH preamble formats 0-4 and] all PUCCH formats 1, 1a, 1b, 2, 2a and 2b are considered to have the same EVM requirement as QPSK modulated.

Table 6.5.2.1.1-1: Minimum requirements for Error Vector Magnitude

Parameter	Unit	Average EVM Level	Reference Signal EVM Level
QPSK or BPSK	%	17.5	[17.5]
16QAM	%	12.5	[12.5]

Table 6.5.2.1.1-2: Parameters for Error Vector Magnitude

Parameter	Unit	Level
UE Output Power	dBm	≥ -40
Operating conditions		Normal conditions

6.5.2.2 Carrier leakage

Carrier leakage (The IQ origin offset) is an additive sinusoid waveform that has the same frequency as the modulated waveform carrier frequency. The measurement interval is one slot in the time domain.

6.5.2.2.1 Minimum requirements

The relative carrier leakage power is a power ratio of the additive sinusoid waveform and the modulated waveform. The relative carrier leakage power shall not exceed the values specified in Table 6.5.2.2.1-1.

Table 6.5.2.2.1-1: Minimum requirements for Relative Carrier Leakage Power

	Parameters	Relative Limit (dBc)
	Output power >0 dBm	-25
	-30 dBm ≤ Output power ≤0 dBm	-20
	-40 dBm ≤ Output power < -30 dBm	-10

6.5.2.3 In-band emissions

The in-band emission is defined as the average across 12 sub-carrier and as a function of the RB offset from the edge of the allocated UL transmission bandwidth. The in-band emission is measured as the ratio of the UE output power in a non–allocated RB to the UE output power in an allocated RB.

The basic in-band emissions measurement interval is defined over one slot in the time domain. When the PUSCH or PUCCH transmission slot is shortened due to multiplexing with SRS, the in-band emissions measurement interval is reduced by one SC-FDMA symbol, accordingly.

6.5.2.3.1 Minimum requirements

The relative in-band emission shall not exceed the values specified in Table 6.5.2.3.1-1.

Table 6.5.2.3.1-1: Minimum requirements for in-band emissions

Parameter Description	Unit	Limit (Note 1)		Applicable Frequencies
General	*dB*	$\max\{ -25-10\cdot\log_{10}(N_{RB}/L_{CRBs}), 20\cdot\log_{10} EVM -3-5\cdot(\lvert\Delta_{RB}\rvert-1)/L_{CRBs}, -57\, dBm/180kHz - P_{RB}\}$		*Any non-allocated (Note 2)*
IQ Image	*dB*	*-25*		*Image frequencies (Notes 2, 3)*
Carrier leakage	*dBc*	*-25*	*Output power > 0 dBm*	*Carrier frequency (Notes 4, 5)*
		-20	*-30 dBm ≤ Output power ≤ 0 dBm*	
		-10	*-40 dBm ≤ Output power < -30 dBm*	

Note 1:	*An in-band emissions combined limit is evaluated in each non-allocated RB. For each such RB, the minimum requirement is calculated as the higher of P_{RB} - 30 dB and the power sum of all limit values (General, IQ Image or Carrier leakage) that apply. P_{RB} is defined in Note 10.*
Note 2:	*The measurement bandwidth is 1 RB and the limit is expressed as a ratio of measured power in one non-allocated RB to the measured average power per allocated RB, where the averaging is done across all allocated RBs.*
Note 3:	*The applicable frequencies for this limit are those that are enclosed in the reflection of the allocated bandwidth, based on symmetry with respect to the centre carrier frequency, but excluding any allocated RBs.*
Note 4:	*The measurement bandwidth is 1 RB and the limit is expressed as a ratio of measured power in one non-allocated RB to the measured total power in all allocated RBs.*
Note 5:	*The applicable frequencies for this limit are those that are enclosed in the RBs containing the DC frequency if N_{RB} is odd, or in the two RBs immediately adjacent to the DC frequency if N_{RB} is even, but excluding any allocated RB.*
Note 6:	L_{CRBs} *is the Transmission Bandwidth (see Figure 5.6-1).*
Note 7:	N_{RB} *is the Transmission Bandwidth Configuration (see Figure 5.6-1).*
Note 8:	EVM *is the limit specified in Table 6.5.2.1.1-1 for the modulation format used in the allocated RBs.*
Note 9:	Δ_{RB} *is the starting frequency offset between the allocated RB and the measured non-allocated RB (e.g.* $\Delta_{RB} = 1$ *or* $\Delta_{RB} = -1$ *for the first adjacent RB outside of the allocated bandwidth.*
Note 10:	P_{RB} *is the transmitted power per 180 kHz in allocated RBs, measured in dBm.*

6.5.2.4 EVM equalizer spectrum flatness

The zero-forcing equalizer correction applied in the EVM measurement process (as described in Annex F) must meet a spectral flatness requirement for the EVM measurement to be valid. The EVM equalizer spectrum flatness is defined in terms of the maximum peak-to-peak ripple of the equalizer coefficients (dB) across the allocated uplink block. The basic measurement interval is the same as for EVM.

6.5.2.4.1 Minimum requirements

The peak-to-peak variation of the EVM equalizer coefficients contained within the frequency range of the uplink allocation shall not exceed the maximum ripple specified in Table 6.5.2.4.1-1 for normal conditions. For uplink allocations contained within both Range 1 and Range 2, the coefficients evaluated within each of these frequency ranges shall meet the corresponding ripple requirement and the following additional requirement: the relative difference between the maximum coefficient in Range 1 and the minimum coefficient in Range 2 must not be larger than 5 dB, and the relative difference between the maximum coefficient in Range 2 and the minimum coefficient in Range 1 must not be larger than 7 dB (see Figure 6.5.2.4.1-1).

The EVM equalizer spectral flatness shall not exceed the values specified in Table 6.5.2.4.1-2 for extreme conditions. For uplink allocations contained within both Range 1 and Range 2, the coefficients evaluated within each of these frequency ranges shall meet the corresponding ripple requirement and the following additional requirement: the relative difference between the maximum coefficient in Range 1 and the minimum coefficient in Range 2 must not be larger than 6 dB, and the relative difference between the maximum coefficient in Range 2 and the minimum coefficient in Range 1 must not be larger than 10 dB (see Figure 6.5.2.4.1-1).

Table 6.5.2.4.1-1: Minimum requirements for EVM equalizer spectrum flatness (normal conditions)

Frequency Range	Maximum Ripple [dB]
$F_{UL\_Meas} - F_{UL\_Low} \geq 3$ MHz and $F_{UL\_High} - F_{UL\_Meas} \geq 3$ MHz (Range 1)	4 (p-p)
$F_{UL\_Meas} - F_{UL\_Low} < 3$ MHz or $F_{UL\_High} - F_{UL\_Meas} < 3$ MHz (Range 2)	8 (p-p)
Note 1: F_{UL_Meas} refers to the sub-carrier frequency for which the equalizer coefficient is evaluated Note 2: F_{UL_Low} and F_{UL_High} refer to each E-UTRA frequency band specified in Table 5.5-1	

Table 6.5.2.4.1-2: Minimum requirements for EVM equalizer spectrum flatness (extreme conditions)

Frequency Range	Maximum Ripple [dB]
$F_{UL\_Meas} - F_{UL\_Low} \geq 5$ MHz and $F_{UL\_High} - F_{UL\_Meas} \geq 5$ MHz (Range 1)	4 (p-p)
$F_{UL\_Meas} - F_{UL\_Low} < 5$ MHz or $F_{UL\_High} - F_{UL\_Meas} < 5$ MHz (Range 2)	12 (p-p)
Note 1: F_{UL_Meas} refers to the sub-carrier frequency for which the equalizer coefficient is evaluated Note 2: F_{UL_Low} and F_{UL_High} refer to each E-UTRA frequency band specified in Table 5.5-1	

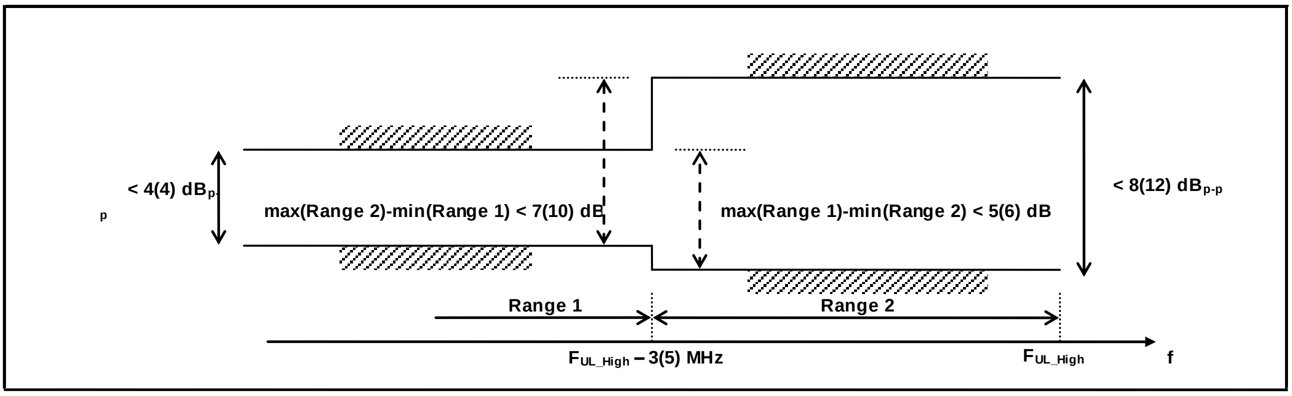


Figure 6.5.2.4.1-1: The limits for EVM equalizer spectral flatness with the maximum allowed variation of the coefficients indicated (the ETC minimum requirement within brackets).

6.5.2A Void

<reserved for future use>

6.5.2B Transmit modulation quality for UL-MIMO

For UE with multiple transmit antenna connectors, the transmit modulation quality requirements are specified at each transmit antenna connector.

The transmit modulation quality is specified in terms of:

- Error Vector Magnitude (EVM) for the allocated resource blocks (RBs)
- EVM equalizer spectrum flatness derived from the equalizer coefficients generated by the EVM measurement process
- Carrier leakage (caused by IQ offset)
- In-band emissions for the non-allocated RB

6.5.2B.1 Error Vector Magnitude

For UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the Error Vector Magnitude requirements specified in Table 6.5.2.1.1-1 which is defined in sub-clause 6.5.2.1 apply to each transmit antenna connector with the uplink MIMO configurations specified in Table 6.2.2B-2.

6.5.2B.2 Carrier leakage

For UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the Relative Carrier Leakage Power requirements specified in Table 6.5.2.2.1-1 which is defined in sub-clause 6.5.2.2 apply to each transmit antenna connector with the uplink MIMO configurations specified in Table 6.2.2B-2.

6.5.2B.3 In-band emissions

For UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the In-band Emission requirements specified in Table 6.5.2.3.1-1 which is defined in sub-clause 6.5.2.3 apply to each transmit antenna connector with the uplink MIMO configurations specified in Table 6.2.2B-2.

6.5.2B.4 EVM equalizer spectrum flatness for UL-MIMO

For UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the EVM Equalizer Spectrum Flatness requirements specified in Table 6.5.2.4.1-1 and Table 6.5.2.4.1-2 which are defined in sub-clause 6.5.2.4 apply to each transmit antenna connector with the uplink MIMO configurations specified in Table 6.2.2B-2.

6.6 Output RF spectrum emissions

The output UE transmitter spectrum consists of the three components; the emission within the occupied bandwidth (channel bandwidth), the Out Of Band (OOB) emissions and the far out spurious emission domain.

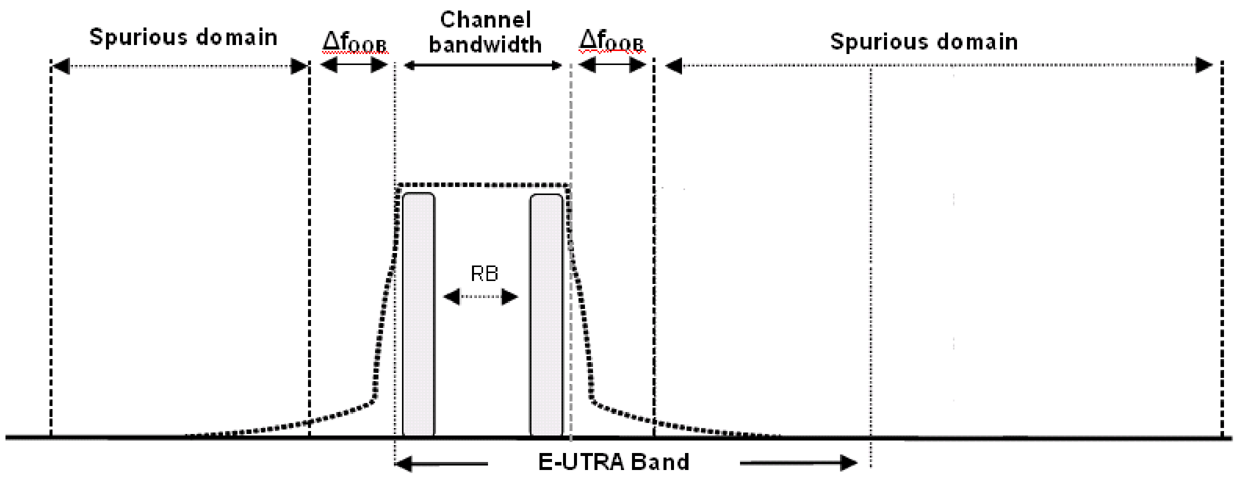


Figure 6.6-1: Transmitter RF spectrum

6.6.1 Occupied bandwidth

Occupied bandwidth is defined as the bandwidth containing 99 % of the total integrated mean power of the transmitted spectrum on the assigned channel. The occupied bandwidth for all transmission bandwidth configurations (Resources Blocks) shall be less than the channel bandwidth specified in Table 6.6.1-1

Table 6.6.1-1: Occupied channel bandwidth

	Occupied channel bandwidth / channel bandwidth					
	1.4 MHz	**3.0 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
Channel bandwidth (MHz)	1.4	3	5	10	15	20

6.6.1A Occupied bandwidth for intra-band contiguous CA

In the case carriers are contiguously aggregated in the uplink (intra-band), occupied bandwidth is a measure of the bandwidth containing 99 % of the total integrated power of the transmitted spectrum. The OBW for intra-band contiguously aggregated carriers shall be less than the aggregated channel bandwidth defined in section 5.6A.

6.6.1B Occupied bandwidth for UL-MIMO

For UE with multiple transmit antenna connectors, the requirements for occupied bandwidth is specified at each transmit antenna connector. The occupied bandwidth is defined as the bandwidth containing 99 % of the total integrated mean power of the transmitted spectrum on the assigned channel at each transmit antenna connector.

For UE with two transmit antenna connectors in closed-loop spatial multiplexing scheme, the occupied bandwidth at each transmitter antenna shall be less than the channel bandwidth specified in Table 6.6.1B-1 with the UL-MIMO configurations specified in Table 6.2.2B-2.

Table 6.6.1B-1: Occupied channel bandwidth

	Occupied channel bandwidth / channel bandwidth					
	1.4 MHz	**3.0 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
Channel bandwidth (MHz)	1.4	3	5	10	15	20

6.6.2 Out of band emission

The Out of band emissions are unwanted emissions immediately outside the assigned channel bandwidth resulting from the modulation process and non-linearity in the transmitter but excluding spurious emissions. This out of band emission limit is specified in terms of a spectrum emission mask and an Adjacent Channel Leakage power Ratio.

6.6.2.1 Spectrum emission mask

The spectrum emission mask of the UE applies to frequencies (Δf_{OOB}) starting from the ± edge of the assigned E-UTRA channel bandwidth. For frequencies greater than (Δf_{OOB}) as specified in Table 6.6.2.1.1-1 the spurious requirements in clause 6.6.3 are applicable.

6.6.2.1.1 Minimum requirement

The power of any UE emission shall not exceed the levels specified in Table 6.6.2.1.1-1 for the specified channel bandwidth.

Table 6.6.2.1.1-1: General E-UTRA spectrum emission mask

Spectrum emission limit (dBm)/ Channel bandwidth							
Δf_{OOB} (MHz)	**1.4 MHz**	**3.0 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**Measurement bandwidth**
± 0-1	-10	-13	-15	-18	-20	-21	30 kHz
± 1-2.5	-10	-10	-10	-10	-10	-10	1 MHz
± 2.5-2.8	-25	-10	-10	-10	-10	-10	1 MHz
± 2.8-5		-10	-10	-10	-10	-10	1 MHz
± 5-6		-25	-13	-13	-13	-13	1 MHz
± 6-10			-25	-13	-13	-13	1 MHz
± 10-15				-25	-13	-13	1 MHz
± 15-20					-25	-13	1 MHz
± 20-25						-25	1 MHz

Note: As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

6.6.2.1A Spectrum emission mask for intra-band contiguous CA

In the case when carriers are contiguously aggregated in the uplink (intra-band), the spectrum emission mask of the UE applies to frequencies (Δf_{OOB}) starting from the ± edge of the aggregated channel bandwidth (Table 5.6A-1)

For CA Bandwidth Class A, the power of any UE emission shall not exceed the levels specified in Table 6.6.2.1.1-1 with the aggregated channel bandwidth replacing the channel bandwidth.

For CA Bandwidth Class C, the power of any UE emission shall not exceed the levels specified in Table 6.6.2.1A-1 for the specified channel bandwidth.

Table 6.6.2.1A-1: General E-UTRA CA spectrum emission mask for Bandwidth Class C

Spectrum emission limit [dBm]/$BW_{Channel\_CA}$				
Δf_{OOB} (MHz)	29.9 MHz	30 MHz	39.8 MHz	Measurement bandwidth
± 0-1	-22.5	-22.5	-24	30 kHz
± 1-5	-10	-10	-10	1 MHz
± 5-29.9	-13	-13	-13	1 MHz
± 29.9-30	-25	-13	-13	1 MHz
± 30-34.9	-25	-25	-13	1 MHz
± 34.9-35		-25	-13	1 MHz
± 35-39.8			-13	1 MHz
± 39.8-44.8			-25	1 MHz

6.6.2.2 Additional Spectrum Emission Mask

This requirement is specified in terms of an "additional spectrum emission" requirement.

6.6.2.2.1 Minimum requirement (network signalled value "NS_03" and "NS_11")

Additional spectrum emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

When "NS_03" or "NS_11" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.6.2.2.1-1.

Table 6.6.2.2.1-1: Additional requirements

	Spectrum emission limit (dBm)/ Channel bandwidth						
Δf_{OOB} (MHz)	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz	Measurement bandwidth
± 0-1	-10	-13	-15	-18	-20	-21	30 kHz
± 1-2.5	-13	-13	-13	-13	-13	-13	1 MHz
± 2.5-2.8	-25	-13	-13	-13	-13	-13	1 MHz
± 2.8-5		-13	-13	-13	-13	-13	1 MHz
± 5-6		-25	-13	-13	-13	-13	1 MHz
± 6-10			-25	-13	-13	-13	1 MHz
± 10-15				-25	-13	-13	1 MHz
± 15-20					-25	-13	1 MHz
± 20-25						-25	1 MHz

Note: As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

6.6.2.2.2 Minimum requirement (network signalled value "NS_04")

Additional spectrum emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

When "NS_04" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.6.2.2.2-1.

Table 6.6.2.2.2-1: Additional requirements

	Spectrum emission limit (dBm)/ Channel bandwidth						
Δf_{OOB} (MHz)	**1.4 MHz**	**3.0 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**Measurement bandwidth**
± 0-1	-10	-13	-15	-18	-20	-21	30 kHz
± 1-2.5	-13	-13	-13	-13	-13	-13	1 MHz
± 2.5-2.8	-25	-13	-13	-13	-13	-13	1 MHz
± 2.8-5.5		-13	-13	-13	-13	-13	1 MHz
± 5.5-6		-25	-25	-25	-25	-25	1 MHz
± 6-10			-25	-25	-25	-25	1 MHz
± 10-15				-25	-25	-25	1 MHz
± 15-20					-25	-25	1 MHz
± 20-25						-25	1 MHz

Note: As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

6.6.2.2.3 Minimum requirement (network signalled value "NS_06" or "NS_07")

Additional spectrum emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

When "NS_06" or "NS_07" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.6.2.2.3-1.

Table 6.6.2.2.3-1: Additional requirements

	Spectrum emission limit (dBm)/ Channel bandwidth				
Δf_{OOB} (MHz)	1.4 MHz	3.0 MHz	5 MHz	10 MHz	Measurement bandwidth
± 0-0.1	-13	-13	-15	-18	30 kHz
± 0.1-1	-13	-13	-13	-13	100 kHz
± 1-2.5	-13	-13	-13	-13	1 MHz
± 2.5-2.8	-25	-13	-13	-13	1 MHz
± 2.8-5		-13	-13	-13	1 MHz
± 5-6		-25	-13	-13	1 MHz
± 6-10			-25	-13	1 MHz
± 10-15				-25	1 MHz

Note: As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

6.6.2.3 Adjacent Channel Leakage Ratio

Adjacent Channel Leakage power Ratio (ACLR) is the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency. ACLR requirements are specified for two scenarios for an adjacent E-UTRA and /or UTRA channel as shown in Figure 6.6.2.3-1.

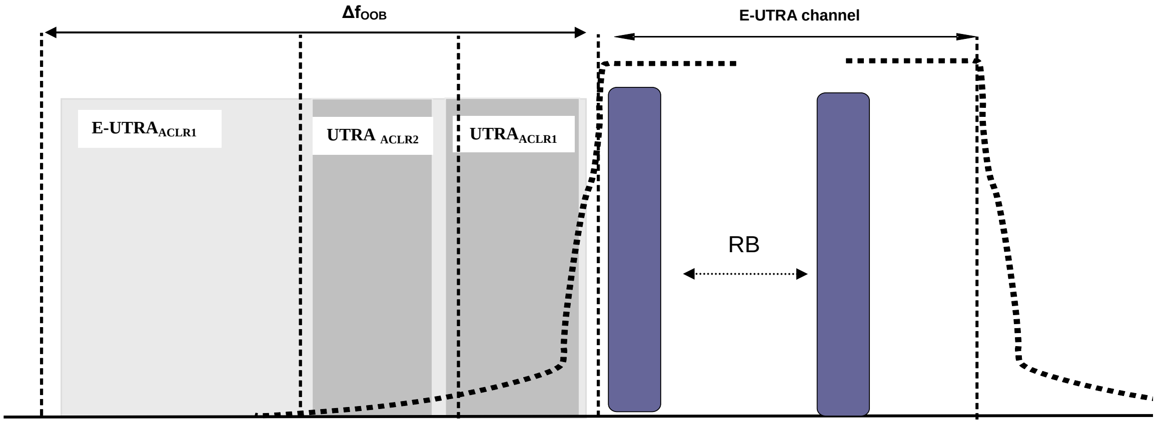


Figure 6.6.2.3-1: Adjacent Channel Leakage requirements

6.6.2.3.1 Minimum requirement E-UTRA

E-UTRA Adjacent Channel Leakage power Ratio (E-UTRA$_{ACLR}$) is the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency at nominal channel spacing. The assigned E-UTRA channel power and adjacent E-UTRA channel power are measured with rectangular filters with measurement bandwidths specified in Table 6.6.2.3.1-1. If the measured adjacent channel power is greater than –50dBm then the E-UTRA$_{ACLR}$ shall be higher than the value specified in Table 6.6.2.3.1-1.

Table 6.6.2.3.1-1: General requirements for E-UTRA$_{ACLR}$

	Channel bandwidth / E-UTRA$_{ACLR1}$ / measurement bandwidth					
	1.4 MHz	**3.0 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
E-UTRA$_{ACLR1}$	30 dB	30 dB	30 dB	30 dB	30 dB	30 dB
E-UTRA channel Measurement bandwidth	1.08 MHz	2.7 MHz	4.5 MHz	9.0 MHz	13.5 MHz	18 MHz
Adjacent channel centre frequency offset (in MHz)	+1.4 / -1.4	+3.0 / -3.0	+5 / -5	+10 / -10	+15 / -15	+20 / -20

6.6.2.3.1A Void

6.6.2.3.2 Minimum requirements UTRA

UTRA Adjacent Channel Leakage power Ratio (UTRA$_{ACLR}$) is the ratio of the filtered mean power centred on the assigned E-UTRA channel frequency to the filtered mean power centred on an adjacent(s) UTRA channel frequency.

UTRA Adjacent Channel Leakage power Ratio is specified for both the first UTRA adjacent channel (UTRA$_{ACLR1}$) and the 2nd UTRA adjacent channel (UTRA$_{ACLR2}$). The UTRA channel power is measured with a RRC bandwidth filter with roll-off factor α =0.22. The assigned E-UTRA channel power is measured with a rectangular filter with measurement bandwidth specified in Table 6.6.2.3.2-1. If the measured UTRA channel power is greater than –50dBm then the UTRA$_{ACLR}$ shall be higher than the value specified in Table 6.6.2.3.2-1.

Table 6.6.2.3.2-1: Requirements for $UTRA_{ACLR1/2}$

	Channel bandwidth / $UTRA_{ACLR1/2}$ / measurement bandwidth					
	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz
$UTRA_{ACLR1}$	33 dB	33 dB	33 dB	33 dB	33 dB	33 dB
Adjacent channel centre frequency offset (in MHz)	0.7+BW_{UTRA}/2 / -0.7-BW_{UTRA}/2	1.5+BW_{UTRA}/2 / -1.5-BW_{UTRA}/2	+2.5+BW_{UTRA}/2 / -2.5-BW_{UTRA}/2	+5+BW_{UTRA}/2 / -5-BW_{UTRA}/2	+7.5+BW_{UTRA}/2 / -7.5-BW_{UTRA}/2	+10+BW_{UTRA}/2 / -10-BW_{UTRA}/2
$UTRA_{ACLR2}$	-	-	36 dB	36 dB	36 dB	36 dB
Adjacent channel centre frequency offset (in MHz)	-	-	+2.5+3*BW_{UTRA}/2 / -2.5-3*BW_{UTRA}/2	+5+3*BW_{UTRA}/2 / -5-3*BW_{UTRA}/2	+7.5+3*BW_{UTRA}/2 / -7.5-3*BW_{UTRA}/2	+10+3*BW_{UTRA}/2 / -10-3*BW_{UTRA}/2
E-UTRA channel Measurement bandwidth	1.08 MHz	2.7 MHz	4.5 MHz	9.0 MHz	13.5 MHz	18 MHz
UTRA 5MHz channel Measurement bandwidth*	3.84 MHz	3.84 MHz	3.84 MHz	3.84 MHz	3.84 MHz	3.84 MHz
UTRA 1.6MHz channel measurement bandwidth**	1.28 MHz	1.28 MHz	1.28 MHz	1.28MHz	1.28MHz	1.28MHz
* Note: Applicable for E-UTRA FDD co-existence with UTRA FDD in paired spectrum. ** Note: Applicable for E-UTRA TDD co-existence with UTRA TDD in unpaired spectrum.						

6.6.2.3.2A Minimum requirement UTRA for CA

UTRA Adjacent Channel Leakage power Ratio ($UTRA_{ACLR}$) is the ratio of the filtered mean power centred on the assigned carrier aggregated E-UTRA channel frequency to the filtered mean power centred on an adjacent(s) UTRA channel frequency.

UTRA Adjacent Channel Leakage power Ratio is specified for both the first UTRA adjacent channel ($UTRA_{ACLR1}$) and the 2nd UTRA adjacent channel ($UTRA_{ACLR2}$). The UTRA channel power is measured with a RRC bandwidth filter with roll-off factor α =0.22. The assigned carrier aggregated E-UTRA channel power is measured with a rectangular filter with measurement bandwidth specified in Table 6.6.2.3.2A-1. If the measured UTRA channel power is greater than –50dBm then the $UTRA_{ACLR}$ shall be higher than the value specified in Table 6.6.2.3.2A-1.

Table 6.6.2.3.2A-1: Requirements for $UTRA_{ACLR1/2}$

	CA bandwidth class / $UTRA_{ACLR1/2}$ / measurement bandwidth
	CA bandwidth class C
$UTRA_{ACLR1}$	33 dB
Adjacent channel centre frequency offset (in MHz)	+ $BW_{Channel\_CA}$ /2 + BW_{UTRA}/2 / - $BW_{Channel\_CA}$ / 2 - BW_{UTRA}/2
$UTRA_{ACLR2}$	36 dB
Adjacent channel centre frequency offset (in MHz)	+ $BW_{Channel\_CA}$ /2 + 3*BW_{UTRA}/2 / - $BW_{Channel\_CA}$ /2 – 3*BW_{UTRA}/2
CA E-UTRA channel Measurement bandwidth	$BW_{Channel\_CA}$ - 2* BW_{GB}
UTRA 5MHz channel Measurement bandwidth*	3.84 MHz
UTRA 1.6MHz channel measurement bandwidth**	1.28 MHz
* Note: Applicable for E-UTRA FDD co-existence with UTRA FDD in paired spectrum. ** Note: Applicable for E-UTRA TDD co-existence with UTRA TDD in unpaired spectrum.	

6.6.2.3.3A Minimum requirement CA E-UTRA for CA

Carrier aggregated E-UTRA Adjacent Channel Leakage power Ratio (CA $E\text{-}UTRA_{ACLR}$) is the ratio of the filtered mean power centred on the assigned aggregated E-UTRA channel frequency to the filtered mean power centred on an adjacent aggregated E-UTRA channel frequency at nominal channel spacing. The assigned aggregated E-UTRA channel power and adjacent aggregated E-UTRA channel power are measured with rectangular filters with measurement bandwidths specified in Table 6.6.2.3.3A-1. If the measured adjacent channel power is greater than –50dBm then the $E\text{-}UTRA_{ACLR}$ shall be higher than the value specified in Table 6.6.2.3.3A-1.

Table 6.6.2.3.3A-1: General requirements for CA $E\text{-}UTRA_{ACLR}$

	CA bandwidth class / CA $E\text{-}UTRA_{ACLR}$ / measurement bandwidth
	CA bandwidth class C
CA $E\text{-}UTRA_{ACLR}$	30 dB
CA E-UTRA channel Measurement bandwidth	$BW_{Channel\_CA}$ - 2* BW_{GB}
Adjacent channel centre frequency offset (in MHz)	+ $BW_{Channel\_CA}$ / - $BW_{Channel\_CA}$

6.6.2.4 Additional ACLR requirements

This requirement is specified in terms of an additional $UTRA_{ACLR2}$ requirement.

6.6.2.4.1 Void

6.6.2A Void

<reserved for future use>

6.6.2B Out of band emission for UL-MIMO

For UE with multiple transmit antenna connectors, the requirements for Out of band emissions resulting from the modulation process and non-linearity in the transmitters are specified at each transmit antenna connector.

For UEs with two transmit antenna connectors, the requirements in sub-clause 6.6.2 apply to each transmit antenna connector with the uplink MIMO configurations specified in Table 6.2.2B-2 for closed-loop spatial multiplexing scheme.

6.6.3 Spurious emissions

Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emissions, intermodulation products and frequency conversion products, but exclude out of band emissions unless otherwise stated. The spurious emission limits are specified in terms of general requirements inline with SM.329 [2] and E-UTRA operating band requirement to address UE co-existence.

6.6.3.1 Minimum requirements

Unless otherwise stated, the spurious emission limits apply for the frequency ranges that are more than Δf_{OOB} (MHz) in Table 6.6.3.1-1 from the edge of the channel bandwidth. The spurious emission limits in Table 6.6.3.1-2 apply for all transmitter band configurations (RB) and channel bandwidths.

Table 6.6.3.1-1: Boundary between E-UTRA Δf_{OOB} and spurious emission domain

Channel bandwidth	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Δf_{OOB} (MHz)	2.8	6	10	15	20	25

To improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

NOTE: In order that the measurement of spurious emissions falls within the frequency ranges that are more than Δf_{OOB} (MHz) from the edge of the channel bandwidth, the minimum offset of the measurement frequency from each edge of the channel should be Δf_{OOB} + MBW/2. MBW denotes the measurement bandwidth defined in Table 6.6.3.1-2.

Table 6.6.3.1-2: Spurious emissions limits

Frequency Range	Maximum Level	Measurement Bandwidth
9 kHz ≤ f < 150 kHz	-36 dBm	1 kHz
150 kHz ≤ f < 30 MHz	-36 dBm	10 kHz
30 MHz ≤ f < 1000 MHz	-36 dBm	100 kHz
1 GHz ≤ f < 12.75 GHz	-30 dBm	1 MHz

6.6.3.1A Minimum requirements for CA

The spurious emission limits apply for the frequency ranges that are more than Δf_{OOB} (MHz) in Table 6.6.3.1A-1 from the ± edge of the aggregated channel bandwidth (Table 5.6A-1). For frequencies Δf_{OOB} greater than F_{OOB} as specified in Table 6.6.3.1A-1the spurious requirements in Table 6.6.3.1-2 are applicable.

Table 6.6.3.1A-1: Boundary between E-UTRA Δf_{OOB} and spurious emission domain for intra-band contiguous carrier aggregation

CA Bandwidth Class	OOB boundary F_{OOB} [(MHz)
A	Table 6.6.3.1-1
B	FFS
C	$BW_{Channel\_CA}$ + 5

To improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

NOTE: In order that the measurement of spurious emissions falls within the frequency ranges that are more than Δf_{OOB} (MHz) from the edge of the channel bandwidth, the minimum offset of the measurement frequency from each edge of the channel should be Δf_{OOB} + MBW/2. MBW denotes the measurement bandwidth defined in Table 6.6.3.1-2.

6.6.3.2 Spurious emission band UE co-existence

This clause specifies the requirements for the specified E-UTRA band, for coexistence with protected bands

NOTE: For measurement conditions at the edge of each frequency range, the lowest frequency of the measurement position in each frequency range should be set at the lowest boundary of the frequency range plus MBW/2. The highest frequency of the measurement position in each frequency range should be set at the highest boundary of the frequency range minus MBW/2. MBW denotes the measurement bandwidth defined for the protected band.

Table 6.6.3.2-1: Requirements

E-UTRA Band	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	Comment
1	E-UTRA Band 1, 3, 7, 8, 9, 11, 20, 21, 34, 38, 40, 42, 43	FDL_low	-	FDL_high	-50	1	
	E-UTRA band 33	FDL_low	-	FDL_high	-50	1	Note[3]
	E-UTRA band 39	FDL_low	-	FDL_high	-50	1	Note[3]
	Frequency range	860	-	895	-50	1	
	Frequency range	1884.5	-	1919.6	-41	0.3	Note[6],Note[7]
		1884.5	-	1915.7			Note [6], Note[8]
2	E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 23, 24, 25, 41, 42, 43	FDL_low	-	FDL_high	-50	1	
3	E-UTRA Band 1, 3, 7, 8, 20, 33, 34, 38, 42, 43	FDL_low	-	FDL_high	-50	1	
	E-UTRA Band 11, 21	FDL_low	-	FDL_high	-50	1	Note[13]
	Frequency range	860	-	895	-50	1	Note[13]
	Frequency range	1884.5	-	1919.6	-41	0.3	Note[13]
4	E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 23, 24, 25, 41, 42, 43	FDL_low	-	FDL_high	-50	1	
5	E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 23, 24, 25, 42, 43	FDL_low	-	FDL_high	-50	1	
	E-UTRA Band 41	FDL_low	-	FDL_high	-50	1	Note[2]
6	E-UTRA Band 1, 9, 11, 34	FDL_low	-	FDL_high	-50	1	
	Frequency range	860	-	875	-37	1	
	Frequency range	875	-	895	-50	1	
	Frequency range	1884.5	-	1919.6	-41	0.3	Note[7]
		1884.5	-	1915.7			Note[8]
7	E-UTRA Band 1, 3, 7, 8, 20, 33, 34, 42, 43	FDL_low	-	FDL_high	-50	1	
	E-UTRA Band 38	FDL_low	-	FDL_high	-50	1	Note [3]
8	E-UTRA Band 1, 8, 20, 33, 34, 38, 39, 40, 42, 43	FDL_low	-	FDL_high	-50	1	

	E-UTRA band 3	FDL_low	-	FDL_high	-50	1	Note [2]
	E-UTRA band 7	FDL_low	-	FDL_high	-50	1	Note [2]
9	E-UTRA Band 1, 9, 11, 21, 34	FDL_low	-	FDL_high	-50	1	
	Frequency range	860	-	895	-50	1	
	Frequency range	1884.5	-	1919.6	-41	0.3	Note[7]
		1884.5	-	1915.7			Note[8]
10	E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 23, 24, 25, 41, 42, 43	FDL_low	-	FDL_high	-50	1	
11	E-UTRA Band 1, 9, 11, 21, 34	FDL_low	-	FDL_high	-50	1	
	Frequency range	860	-	895	-50	1	
	Frequency range	1884.5		1919.6	-41	0.3	Note[7]
		1884.5	-	1915.7			Note[8]
12	E-UTRA Band 2, 5, 12, 13, 14, 17, 23, 24, 25, 41	FDL_low	-	FDL_high	-50	1	
	E-UTRA Band 4, 10	FDL_low	-	FDL_high	-50	1	Note[2]
13	E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 23, 25, 41	FDL_low	-	FDL_high	-50	1	
	Frequency range	769	-	775	-35	0.00625	
	Frequency range	799	-	805	-35	0.00625	Note[11]
	E-UTRA Band 24	FDL_low	-	FDL_high	-50	1	Note[2]
14	E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 23, 24, 25, 41	FDL_low	-	FDL_high	-50	1	
	Frequency range	769	-	775	-35	0.00625	Note[12]
	Frequency range	799	-	805	-35	0.00625	Note[11], Note[12]
17	E-UTRA Band 2, 5, 12, 13, 14, 17, 23, 24, 25, 41	FDL_low	-	FDL_high	-50	1	
	E-UTRA Band 4, 10	FDL_low	-	FDL_high	-50	1	Note[2]
18	E-UTRA Band 1, 9, 11, 21, 34	FDL_low	-	FDL_high	-50	1	
	Frequency range	860	-	895	-40	1	
	Frequency range	1884.5	-	1919.6	-41	0.3	Note[7]
		1884.5	-	1915.7			Note[8]
19	E-UTRA Band 1, 9, 11, 21, 34	FDL_low	-	FDL_high	-50	1	
	Frequency range	860	-	895	-40	1	Note[9]
	Frequency range	1884.5	-	1919.6	-41	0.3	Note[7]
		1884.5	-	1915.7			Note[8]
20	E-UTRA Band 1, 3, 7, 8, 20, 33, 34, 42, 43	FDL_low	-	FDL_high	-50	1	
	E-UTRA Band 38	FDL_low	-	FDL_high	-50	1	Note [2]
21	E-UTRA Band 11, 21	FDL_low	-	FDL_high	-35	1	Note[10]
	E-UTRA Band 1, 9, 34	FDL_low	-	FDL_high	-50	1	
	Frequency range	860	-	895	-50	1	

		1884.5		1919.6	-41	0.3	Note[7]
	Frequency range	1884.5	-	1915.7			Note[8]
…							
23	E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 23, 24, 41	FDL_low	-	FDL_high	-50	1	Note[14]
	Frequency range	1998	-	1999	-21	1	Note[14]
	Frequency range	1997	-	1998	-27	1	Note[14]
	Frequency range	1996	-	1997	-32	1	Note[14]
	Frequency range	1995	-	1996	-37	1	Note[14]
24	E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 23, 24, 25, 41	FDL_low	-	FDL_high	-50	1	
25	E-UTRA Band 2, 4, 5, 10,12, 13, 14, 17, 24, 25, 41, 42, 43	FDL_low	-	FDL_high	-50	1	
…							
33	E-UTRA Band 1, 3, 7, 8, 20, 34, 38, 39, 40, 42, 43	FDL_low	-	FDL_high	-50	1	Note[5]
34	E-UTRA Band 1, 3, 7, 8, 9, 11, 20, 21, 33, 38,39, 40, 42, 43	FDL_low	-	FDL_high	-50	1	Note[5]
	Frequency range	860	-	895	-50	1	
		1884.5	-	1919.6	-41	0.3	Note[7]
	Frequency range	1884.5	-	1915.7			Note[8]
35							
36							
37			-				
38	E-UTRA Band 1,3, 8, 20, 33, 34, 42, 43	FDL_low	-	FDL_high	-50	1	
	E-UTRA Band 7	FDL_low	-	FDL_high	-50	1	Note[3]
39	E-UTRA Band 34, 40	FDL_low	-	FDL_high	-50	1	
40	E-UTRA Band 1, 3, 33, 34, 39, 42, 43	FDL_low	-	FDL_high	-50	1	
41	E-UTRA Band 2, 4, 5, 10, 12, 13 , 14, 17, 23, 24, 25	FDL_low	-	FDL_high	-50	1	
42	E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 10, 20, 25, 33, 34, 38, 40	FDL_low	-	FDL_high	-50	1	
	E-UTRA Band 43	FDL_low	-	FDL_high	-50	1	Note[3]
43	E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 10, 20, 25, 33, 34, 38, 40	FDL_low	-	FDL_high	-50	1	
	E-UTRA Band 42	FDL_low	-	FDL_high	-50	1	Note[3]

Note [1]	FDL_low and FDL_high refer to each E-UTRA frequency band specified in Table 5.5-1
Note [2]	As exceptions, measurements with a level up to the applicable requirements defined in Table 6.6.3.1-2 are permitted for each assigned E-UTRA carrier used in the measurement due to 2nd or 3rd harmonic spurious emissions. An exception is allowed if there is at least one individual RE within the transmission bandwidth (see Figure 5.6-1) for which the 2nd or 3rd harmonic, i.e. the frequency equal to two or three times the frequency of that RE, is within the measurement bandwidth (MBW).
Note [3]	To meet these requirements some restriction will be needed for either the operating band or protected band
Note [4]	N/A
Note [5]	For non synchronised TDD operation to meet these requirements some restriction will be needed for either the operating band or protected band
Note [6]	Applicable when NS_05 in section 6.6.3.3.1 is signalled by the network.
Note [7]	Applicable when co-existence with PHS system operating in 1884.5-1919.6MHz.
Note [8]	Applicable when co-existence with PHS system operating in 1884.5 -1915.7MHz.
Note [9]	Applicable when NS_08 in section 6.6.3.3.3 is signalled by the network
Note [10]	Applicable when NS_09 in section 6.6.3.3.4 is signalled by the network
Note [11]	Whether the applicable frequency range should be 793-805MHz instead of 799-805MHz is TBD
Note[12]	The emissions measurement shall be sufficiently power averaged to ensure a standard deviation < 0.5 dB
Note[13]	Applicable when the assigned E-UTRA UL operating channel is ≥1749.9MHz and ≤ 1784.9MHz.
Note[14]	To meet this requirement NS_11 value shall be signalled when operating in 2000-2010 MHz

6.6.3.3 Additional spurious emissions

These requirements are specified in terms of an additional spectrum emission requirement. Additional spurious emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

6.6.3.3.1 Minimum requirement (network signalled value "NS_05")

When "NS_05" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.6.3.3.1-1. This requirement also applies for the frequency ranges that are less than Δf_{OOB} (MHz) in Table 6.6.3.1-1 from the edge of the channel bandwidth.

Table 6.6.3.3.1-1: Additional requirements (PHS)

Frequency band (MHz)	Channel bandwidth / Spectrum emission limit (dBm)				Measurement bandwidth
	5 MHz	10 MHz	15 MHz	20 MHz	
1884.5 ≤ f ≤1919.6[*1]	-41	-41	-41	-41	300 KHz
1884.5 ≤ f ≤1915.7[*2]	-41	-41	-41	-41	300 KHz
Note 1. Applicable when the lower edge of the assigned E-UTRA UL channel bandwidth frequency is larger than or equal to the upper edge of PHS band (1919.6 MHz) + 4 MHz + the Channel BW assigned, where Channel BW is as defined in Subclause 5.6. Operations below this point are for further study. 2. Applicable when the lower edge of the assigned E-UTRA UL channel bandwidth frequency is larger than or equal to the upper edge of PHS band (1915.7 MHz) + 4 MHz + the Channel BW assigned, where Channel BW is as defined in Subclause 5.6. Operations below this point are for further study.					

NOTE: For measurement conditions at the edge of each frequency range, the lowest frequency of the measurement position in each frequency range should be set at the lowest boundary of the frequency range plus MBW/2. The highest frequency of the measurement position in each frequency range should be set at the highest boundary of the frequency range minus MBW/2. MBW denotes the measurement bandwidth (300 kHz).

6.6.3.3.2 Minimum requirement (network signalled value "NS_07")

When "NS_07" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.6.3.3.2-1.

Table 6.6.3.3.2-1: Additional requirements

Frequency band (MHz)	Channel bandwidth / Spectrum emission limit (dBm)	Measurement bandwidth
	10 MHz	
769 ≤ f ≤ 775	-57	6.25 kHz
Note: The emissions measurement shall be sufficiently power averaged to ensure a standard deviation < 0.5 dB.		

NOTE: For measurement conditions at the edge of each frequency range, the lowest frequency of the measurement position in each frequency range should be set at the lowest boundary of the frequency range plus MBW/2. The highest frequency of the measurement position in each frequency range should be set at the highest boundary of the frequency range minus MBW/2. MBW denotes the measurement bandwidth (6.25 kHz).

6.6.3.3.3 Minimum requirement (network signalled value "NS_08")

When "NS 08" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.6.3.3.3-1. This requirement also applies for the frequency ranges that are less than Δf_{OOB} (MHz) in Table 6.6.3.1-1 from the edge of the channel bandwidth.

Table 6.6.3.3.3-1 Additional requirement

Frequency band (MHz)	Channel bandwidth / Spectrum emission limit (dBm)			Measurement bandwidth
	5MHz	10MHz	15MHz	
860 ≤ f ≤ 895	-40	-40	-40	1 MHz

NOTE: For measurement conditions at the edge of each frequency range, the lowest frequency of the measurement position in each frequency range should be set at the lowest boundary of the frequency range plus MBW/2. The highest frequency of the measurement position in each frequency range should be set at the highest boundary of the frequency range minus MBW/2. MBW denotes the measurement bandwidth (1 MHz).

6.6.3.3.4 Minimum requirement (network signalled value "NS_09")

When "NS 09" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.6.3.3.4-1. This requirement also applies for the frequency ranges that are less than Δf_{OOB} (MHz) in Table 6.6.3.1-1 from the edge of the channel bandwidth.

Table 6.6.3.3.4-1 Additional requirement

Frequency band (MHz)	Channel bandwidth / Spectrum emission limit (dBm)			Measurement bandwidth
	5MHz	10MHz	15MHz	
1475.9 ≤ f ≤ 1510.9	-35	-35	-35	1 MHz

NOTE 1: For measurement conditions at the edge of each frequency range, the lowest frequency of the measurement position in each frequency range should be set at the lowest boundary of the frequency range plus MBW/2. The highest frequency of the measurement position in each frequency range should be set at the highest boundary of the frequency range minus MBW/2. MBW denotes the measurement bandwidth (1 MHz).

NOTE 2: To improve measurement accuracy, A-MPR values for NS_09 specified in Table 6.2.4-1 in sub-clause 6.2.4 are derived based on both the above NOTE 1 and 100 kHz RBW.

6.6.3A Void

<reserved for future use>

6.6.3B Spurious emission for UL-MIMO

For UE with multiple transmit antenna connectors, the requirements for Spurious emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emissions, intermodulation products and frequency conversion products are specified at each transmit antenna connector.

For UEs with two transmit antenna connectors, the requirements in sub-clause 6.6.3 apply to each transmit antenna with the UL-MIMO configurations specified in Table 6.2.2B-1 for closed-loop spatial multiplexing scheme.

6.6A Void

6.6B Void

6.7 Transmit intermodulation

The transmit intermodulation performance is a measure of the capability of the transmitter to inhibit the generation of signals in its non linear elements caused by presence of the wanted signal and an interfering signal reaching the transmitter via the antenna.

6.7.1 Minimum requirement

User Equipment(s) transmitting in close vicinity of each other can produce intermodulation products, which can fall into the UE, or eNode B receive band as an unwanted interfering signal. The UE intermodulation attenuation is defined by the ratio of the mean power of the wanted signal to the mean power of the intermodulation product when an interfering CW signal is added at a level below the wanted signal at each of the transmitter antenna port with the other antenna port(s) if any is terminated. Both the wanted signal power and the intermodulation product power are measured through E-UTRA rectangular filter with measurement bandwidth shown in Table 6.7.1-1.

The requirement of transmitting intermodulation is prescribed in Table 6.7.1-1.

Table 6.7.1-1: Transmit Intermodulation

BW Channel (UL)	*5MHz*		*10MHz*		*15MHz*		*20MHz*	
Interference Signal Frequency Offset	*5MHz*	*10MHz*	*10MHz*	*20MHz*	*15MHz*	*30MHz*	*20MHz*	*40MHz*
Interference CW Signal Level	*-40dBc*							
Intermodulation Product	*-29dBc*	*-35dBc*	*-29dBc*	*-35dBc*	*-29dBc*	*-35dBc*	*-29dBc*	*-35dBc*
Measurement bandwidth	*4.5MHz*	*4.5MHz*	*9.0MHz*	*9.0MHz*	*13.5MHz*	*13.5MHz*	*18MHz*	*18MHz*

6.7.1A Minimum requirement for CA

User Equipment(s) transmitting in close vicinity of each other can produce intermodulation products, which can fall into the UE, or eNode B receive band as an unwanted interfering signal. The UE intermodulation attenuation is defined by the ratio of the mean power of the wanted signal to the mean power of the intermodulation product on both component carriers when an interfering CW signal is added at a level below the wanted signal at each of the transmitter antenna port with the other antenna port(s) if any is terminated. Both the wanted signal power and the intermodulation product power are measured through rectangular filter with measurement bandwidth shown in Table 6.7.1A-1.

The requirement of transmitting intermodulation is prescribed in Table 6.7.1A-1.

Table 6.7.1A-1: Transmit Intermodulation

CA bandwidth class (UL)	C	
Interference Signal Frequency Offset	$BW_{Channel\_CA}$	$2*BW_{Channel\_CA}$
Interference CW Signal Level	-40dBc	
Intermodulation Product	[-29dBc]	[-35dBc]
Measurement bandwidth	$BW_{Channel\_CA}$- 2* BW_{GB}	

6.7.1B Minimum requirement for UL-MIMO

For UE with multiple antenna transmit connectors, the transmit intermodulation requirements are specified at each transmit antenna connector and the wanted signal is defined as the sum of output power at each transmit antenna connector.

For UEs with two transmit antenna connectors supporting dual-layer transmission, the requirements in sub-clause 6.7.1 apply to each transmit antenna connector with the UL-MIMO configurations specified in Table 6.2.2B-2.

6.8 Time alignment between transmitter branches for UL-MIMO

For UE(s) with multiple transmit antenna connectors, this requirement applies to frame timing differences between transmissions on multiple transmit antenna connectors in the closed-loop spatial multiplexing scheme.

The time alignment error (TAE) is defined as the average frame timing difference between any two transmissions on different transmit antenna connectors.

6.8.1 Minimum Requirements

For UE(s) with multiple transmit antenna connectors, the Time Alignment Error (TAE) shall not exceed [130] ns.

7 Receiver characteristics

7.1 General

Unless otherwise stated the receiver characteristics are specified at the antenna connector(s) of the UE. For UE(s) with an integral antenna only, a reference antenna(s) with a gain of 0 dBi is assumed for each antenna port(s). UE with an integral antenna(s) may be taken into account by converting these power levels into field strength requirements, assuming a 0 dBi gain antenna. . For UEs with more than one receiver antenna connector, identical interfering signals shall be applied to each receiver antenna port if more than one of these is used (diversity).

The levels of the test signal applied to each of the antenna connectors shall be as defined in the respective sections below.

With the exception of Clause 7.3, the requirements shall be verified with the network signalling value NS_01 configured (Table 6.2.4-1).

All the parameters in clause 7 are defined using the UL reference measurement channels specified in Annexes A.2.2 and A.2.3, the DL reference measurement channels specified in Annex A.3.2 and using the set-up specified in Annex C.3.1

7.2 Diversity characteristics

The requirements in Section 7 assume that the receiver is equipped with two Rx port as a baseline. These requirements apply to all UE categories unless stated otherwise. Requirements for 4 ports are FFS. With the exception of clause 7.9 all requirements shall be verified by using both (all) antenna ports simultaneously.

7.3 Reference sensitivity power level

The reference sensitivity power level REFSENS is the minimum mean power applied to both the UE antenna ports at which the throughput shall meet or exceed the requirements for the specified reference measurement channel.

7.3.1 Minimum requirements (QPSK)

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Table 7.3.1-1 and table 7.3.1-2

Table 7.3.1-1: Reference sensitivity QPSK $P_{REFSENS}$

Channel bandwidth							
E-UTRA Band	**1.4 MHz (dBm)**	**3 MHz (dBm)**	**5 MHz (dBm)**	**10 MHz (dBm)**	**15 MHz (dBm)**	**20 MHz (dBm)**	**Duplex Mode**
1	-	-	-100	-97	-95.2	-94	FDD
2	-102.7	-99.7	-98	-95	-93.2	-92	FDD
3	-101.7	-98.7	-97	-94	-92.2	-91	FDD
4	-104.7	-101.7	-100	-97	-95.2	-94	FDD
5	-103.2	-100.2	-98	-95			FDD
6			-100	-97			FDD
7			-98	-95	-93.2	-92	FDD
8	-102.2	-99.2	-97	-94			FDD
9			-99	-96	-94.2	-93	FDD
10			-100	-97	-95.2	-94	FDD
11			-100	-97			FDD
12	-101.7	-98.7	-97	-94			FDD
13			-97	-94			FDD
14		-99.2	-97	-94			FDD
…							
17	-102.2	-99.2	-97	-94			FDD
18			-100	-97	-95.2		FDD
19			-100	-97	-95.2		FDD
20			-97	-94	-91.2	-90	FDD
21			-100	-97	-95.2		FDD
…							
23	-104.7	-101.7	-100	-97			FDD
24			-100	-97			FDD
25	-101.2	-98.2	-96.5	-93.5	-91.7	-90.5	FDD
…							
33			-100	-97	-95.2	-94	TDD
34			-100	-97	-95.2	-94	TDD
35	-106.2	-102.2	-100	-97	-95.2	-94	TDD
36	-106.2	-102.2	-100	-97	-95.2	-94	TDD
37			-100	-97	-95.2	-94	TDD
38			-100	-97	-95.2	-94	TDD
39			-100	-97	-95.2	-94	TDD
40			-100	-97	-95.2	-94	TDD
41			-99	-96	-94.2	-93	TDD
42			[-100]	[-97]	[-95.2]	[-94]	TDD
43			[-100]	[-97]	[-95.2]	[-94]	TDD
Note 1: The transmitter shall be set to P_{UMAX} as defined in clause 6.2.5 Note 2: Reference measurement channel is A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1 Note 3: The signal power is specified per port Note 4: For the UE which supports both Band 3 and Band 9 the reference sensitivity level is FFS. Note 5: For the UE which supports both Band 11 and Band 21 the reference sensitivity level is FFS.							

The reference receive sensitivity (REFSENS) requirement specified in Table 7.3.1-1 shall be met for an uplink transmission bandwidth less than or equal to that specified in Table 7.3.1-2.

Note: Table 7.3.1-2 is intended for conformance tests and does not necessarily reflect the operational conditions of the network, where the number of uplink and downlink allocated resource blocks will be practically constrained by other factors. Typical receiver sensitivity performance with HARQ retransmission enabled and using a residual BLER metric relevant for e.g. Speech Services is given in the Annex X (informative).

For the UE which supports inter-band CA configuration in Table 7.3.1A-2 , the minimum requirement for reference sensitivity in Table 7.3.1-1 shall be increased by the amount given in ΔR_{IB} in Table7.3.1A-2 for the applicable E-UTRA bands.

Table 7.3.1A-2: ΔR_{IB}

Inter-band CA Configuration	E-UTRA Band	ΔR_{IB} [dB]
CA_1A-5A	1	0
	5	0

Table 7.3.1-2: Uplink configuration for reference sensitivity

E-UTRA Band / Channel bandwidth / NRB / Duplex mode							
E-UTRA Band	**1.4 MHz**	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**Duplex Mode**
1	-	-	25	50	75	100	FDD
2	6	15	25	50	50[1]	50[1]	FDD
3	6	15	25	50	50[1]	50[1]	FDD
4	6	15	25	50	75	100	FDD
5	6	15	25	25[1]			FDD
6			25	25[1]			FDD
7			25	50	75[1]	75[1]	FDD
8	6	15	25	25[1]	-	-	FDD
9			25	50	50[1]	50[1]	FDD
10			25	50	75	100	FDD
11			25	25[1]			FDD
12	6	15	20[1]	20[1]			FDD
13			20[1]	20[1]			FDD
14		15	15[1]	15[1]			FDD
...							
17			20[1]	20[1]			FDD
18			25	25[1]	25[1]		FDD
19			25	25[1]	25[1]		FDD
20			25	20[1]	20[3]	20[3]	FDD
21			25	25[1]	25[1]		FDD
…							
23	6	15	25	50			FDD
24			25	50			FDD
25	6	15	25	50	50[1]	50[1]	FDD
…							
33			25	50	75	100	TDD
34			25	50	75		TDD
35	6	15	25	50	75	100	TDD
36	6	15	25	50	75	100	TDD
37			25	50	75	100	TDD
38			25	50	75	100	TDD
39			25	50	75	100	TDD
40			25	50	75	100	TDD
41			25	50	75	100	TDD
42			25	50	75	100	TDD
43			25	50	75	100	TDD

Note
1. The UL resource blocks shall be located as close as possible to the downlink operating band but confined within the transmission bandwidth configuration for the channel bandwidth (Table 5.6-1).
2. For the UE which supports both Band 11 and Band 21 the uplink configuration for reference sensitivity is FFS.
3. For Band 20; in the case of 15MHz channel bandwidth, the UL resource blocks shall be located at RBstart _11 and in the case of 20MHz channel bandwidth, the UL resource blocks shall be located at RBstart _16

Unless given by Table 7.3.1-3, the minimum requirements specified in Tables 7.3.1-1 and 7.3.1-2 shall be verified with the network signalling value NS_01 (Table 6.2.4-1) configured.

Table 7.3.1-3: Network Signalling Value for reference sensitivity

E-UTRA Band	Network Signalling value
2	NS_03
4	NS_03
10	NS_03
12	NS_06
13	NS_06
14	NS_06
17	NS_06
19	NS_08
21	NS_09
23	NS_03

7.3.1A Minimum requirements (QPSK) for CA

For CA bandwidth class A the throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Table 7.3.1-1 and table 7.3.1-2.

For the UE that supports inter band CA the reference sensitivity is defined to be met with both downlink component carriers active and either of the uplink component carriers active.. The UE shall meet the requirements specified in chapter 7.3.1.

For CA bandwidth class C the throughput of each component carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Table 7.3.1-1 and table 7.3.1A-1.

Table 7.3.1A-1 specifies the maximum number of allocated uplink resource blocks for which the intra-band contiguous CA reference receive sensitivity requirement must be met. The PCC allocation follows table 7.3.1-2. SCC and PCC transmission forms a contiguous allocation.

PCC and SCC TX–RX frequency separations are as defined in Table 5.7.4-1.

Table 7.3.1A-1: Intra-band CA uplink configuration for reference sensitivity

CA Band / Aggregated channel bandwidth / NRB / Duplex mode							
CA Band	100RB+50RB		75RB+75RB		100RB+100RB		Duplex Mode
CA_1C	n/a	n/a	PCC	SCC	PCC	SCC	FDD
	n/a	n/a	75	55	100	30	
CA_40C	PCC	SCC	PCC	SCC	PCC	SCC	TDD
	100	50	75	75	100	100	
NOTE 1. The carrier centre frequency of SCC in the UL operating band is configured closer to the DL operating band. NOTE 2. The transmitted power over both PCC and SCC shall be set to P_{UMAX} as defined in clause 6.2.5. NOTE 3. The UL resource blocks in both PCC and SCC shall be confined within the transmission bandwidth configuration for the channel bandwidth (Table 5.6-1).							

7.3.1B Minimum requirements (QPSK) for UL-MIMO

For UE with two transmitter antenna connectors in closed-loop spatial multiplexing scheme, the minimum requirements in Clause 7.3.1 shall be met with the UL-MIMO configurations specified in Table 6.2.2B-2. For UL-MIMO, the parameter P_{UMAX} is the total transmitter power over the two transmit antenna connectors.

7.3.2 Requirement for large transmission configurations

For some combinations of bandwidths and operating bands, a certain relaxation of the UE performance is allowed when the transmission configuration is larger than that in Table 7.3.1-2. Table 7.3.2-1 specifies the allowed maximum sensitivity degradation (MSD) when the UL resource block allocation is the maximum supported transmission bandwidth configuration N_{RB} (Table 5.6-1). Unless given by Table 7.3.1-3, the MSD shall be verified with the network signalling value NS_01 (Table 6.2.4-1) configured.

Table 7.3.2-1: Maximum Sensitivity Degradation

	Channel bandwidth						
E-UTRA Band	1.4 MHz (dB)	3 MHz (dB)	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	Duplex Mode
1			n/a	n/a	n/a	n/a	FDD
2	n/a	n/a	n/a	n/a	TBD	TBD	FDD
3	n/a	n/a	n/a	n/a	TBD	TBD	FDD
4	n/a	n/a	n/a	n/a	n/a	n/a	FDD
5	n/a	n/a	n/a	TBD			FDD
6			n/a	TBD			FDD
7			n/a	n/a	TBD	TBD	FDD
8	n/a	n/a	n/a	TBD			FDD
9			n/a	n/a	TBD	TBD	FDD
10			n/a	n/a	n/a	n/a	FDD
11			n/a	TBD			FDD
12			TBD	TBD			FDD
13			TBD	TBD			FDD
14							FDD
17			TBD	TBD			FDD
18			n/a	TBD	TBD		FDD
19			n/a	TBD	TBD		FDD
20			n/a	TBD	TBD	TBD	FDD
21			n/a	TBD	TBD		FDD
23	n/a	n/a	n/a	n/a			FDD
24			n/a	n/a			
25	n/a	n/a	n/a	n/a	TBD	TBD	FDD
Note: 1. The transmitter shall be set to P_{UMAX} as defined in clause 6.2.5 with the maximum transmission configuration (Table 5.5-1) allocated							

7.4 Maximum input level

This is defined as the maximum mean power received at the UE antenna port, at which the specified relative throughput shall meet or exceed the minimum requirements for the specified reference measurement channel.

7.4.1 Minimum requirements

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Table 7.4.1.

Table 7.4.1-1: Maximum input level

Rx Parameter	Units	Channel bandwidth					
		1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Power in Transmission Bandwidth Configuration	dBm	-25					
Note: 1. The transmitter shall be set to 4dB below P_{CMAX_L} at the minimum uplink configuration specified in Table 7.3.1-2 with P_{CMAX_L} as defined in clause 6.2.5. 2. Reference measurement channel is Annex A.3.2: 64QAM, R=3/4 variant with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1.							

7.4.1A Void

<reserved for future use>

7.4.1B Minimum requirements for UL-MIMO

For UE with two transmitter antenna connectors in closed-loop spatial multiplexing, the minimum requirements in Clause 7.4.1 shall be met with the UL-MIMO configurations specified in Table 6.2.2B-2. For UL-MIMO, the parameter P_{CMAX_L} is defined as the total transmitter power over the two transmit antenna connectors.

7.4A UE maximum input level for CA

This is defined as the maximum mean power received at the UE antenna port over the aggregated channel bandwidth for intra-band contiguous carrier aggregation, at which the specified relative throughput shall meet or exceed the minimum requirements for the specified reference measurement channel over each component carrier.

7.4A.1 Minimum requirements for CA

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels over each component carrier as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Table 7.4A.1-1.

Table 7.4A.1-1: Maximum input level for intra-band contiguous CA

Rx Parameter	Units	CA Bandwidth Class					
		A	B	C	D	E	F
Power in Transmission Aggregated Bandwidth Configuration	dBm			-22			
Note: 1. The transmitter shall be set to 4dB below P_{CMAX_L} at the minimum uplink configuration specified in Table 7.3.1A-1 with P_{CMAX_L} as defined in clause 6.2.5. 2. Reference measurement channel is Annex A.3.2: 64QAM, R=3/4 variant with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1.							

7.5 Adjacent Channel Selectivity (ACS)

7.5.1 Minimum requirements

Adjacent Channel Selectivity (ACS) is a measure of a receiver's ability to receive a E-UTRA signal at its assigned channel frequency in the presence of an adjacent channel signal at a given frequency offset from the centre frequency of the assigned channel. ACS is the ratio of the receive filter attenuation on the assigned channel frequency to the receive filter attenuation on the adjacent channel(s).

The UE shall fulfil the minimum requirement specified in Table 7.5.1-1 for all values of an adjacent channel interferer up to –25 dBm. However it is not possible to directly measure the ACS, instead the lower and upper range of test parameters are chosen in Table 7.5.1-2 and Table 7.5.1-3 where the throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1).

Table 7.5.1-1: Adjacent channel selectivity

		Channel bandwidth					
Rx Parameter	**Units**	**1.4 MHz**	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
ACS	dB	33.0	33.0	33.0	33.0	30	27

Table 7.5.1-2: Test parameters for Adjacent channel selectivity, Case 1

Rx Parameter	Units	Channel bandwidth					
		1.4 MHz	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
Power in Transmission Bandwidth Configuration	dBm	REFSENS + 14 dB					
$P_{Interferer}$	dBm	REFSENS +45.5dB	REFSENS +45.5dB	REFSENS +45.5dB*	REFSENS +45.5dB	REFSENS +42.5dB	REFSENS +39.5dB
$BW_{Interferer}$	MHz	1.4	3	5	5	5	5
$F_{Interferer}$ (offset)	MHz	1.4+0.0025 / -1.4-0.0025	3+0.0075 / -3-0.0075	5+0.0025 / -5-0.0025	7.5+0.0075 / -7.5-0.0075	10+0.0125 / -10-0.0125	12.5+0.0025 / -12.5-0.0025

Note:

8. The transmitter shall be set to 4dB below P_{CMAX_L} at the minimum uplink configuration specified in Table 7.3.1-2 with P_{CMAX_L} as defined in clause 6.2.5.
9. The interferer consists of the Reference measurement channel specified in Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1 and set-up according to Annex C.3.1

Table 7.5.1-3: Test parameters for Adjacent channel selectivity, Case 2

Rx Parameter	Units	Channel bandwidth					
		1.4 MHz	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
Power in Transmission Bandwidth Configuration	dBm	-56.5	-56.5	-56.5	-56.5	-53.5	-50.5
$P_{Interferer}$	dBm	-25					
$BW_{Interferer}$	MHz	1.4	3	5	5	5	5
$F_{Interferer}$ (offset)	MHz	1.4+0.0025 / -1.4-0.0025	3+0.0075 / -3-0.0075	5+0.0025 / -5-0.0025	7.5+0.0075 / -7.5-0.0075	10+0.0125 / -10-0.0125	12.5+0.0025 / -12.5-0.0025

Note:

1. The transmitter shall be set to 24dB below P_{CMAX_L} at the minimum uplink configuration specified in Table 7.3.1-2 with P_{CMAX_L} as defined in clause 6.2.5.
2. The interferer consists of the Reference measurement channel specified in Annex 3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1 and set-up according to Annex C.3.1

7.5.1A Minimum requirements for CA

For intra-band contiguous CA (bandwidth Class C) the downlink Secondary CC shall be configured at nominal channel spacing to the Primary CC with the Primary CC configured closest the uplink band. Downlink Primary CC and Secondary CC are both activated. The uplink output power shall be set as specified in Table 7.5.1A-1 with the uplink configuration according to Table 7.3.1A-1 for the applicable CA Band. For UE(s) supporting one uplink, the uplink configuration of the Primary CC shall be in accordance with Table 7.3.1.

The UE shall fulfil the minimum requirement specified in Table 7.5.1A-1 for an adjacent channel interferer on either side of the aggregated downlink signal at a specified frequency offset and for an interferer power up to -25 dBm.

The throughput of each carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Tables 7.6.1.1A-1 and 7.6.1.1A-2.

Table 7.5.1A-1: Adjacent channel selectivity

		CA Bandwidth Class				
Rx Parameter	Units	B	C	D	E	F
ACS	dB		24			

Table 7.5.1A-2: Test parameters for Adjacent channel selectivity, Case 1

Rx Parameter	Units	CA Bandwidth Class				
		B	C	D	E	F
Power per CC in Aggregated Transmission Bandwidth Configuration			REFSENS + 14 dB			
$P_{Interferer}$	dBm		Aggregated power + 22.5 dB			
$BW_{Interferer}$	MHz		5			
$F_{Interferer}$ (offset)	MHz		2.5 + F_{offset} / -2.5 - F_{offset}			
Note 1: The transmitter shall be set to 4dB below P_{CMAX_L} at the minimum uplink configuration specified in Table 7.3.1-2 with P_{CMAX_L} as defined in clause 6.2.5A. Note 2: The interferer consists of the Reference measurement channel specified in Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1 and set-up according to Annex C.3.1 Note 3: The $F_{interferer}$ (offset) is relative to the center frequency of the adjacent CC being tested and shall be further adjusted to $\lfloor F_{interferer}/0.015+0.5 \rfloor 0.015+0.0075$ MHz to be offset from the sub-carrier raster.						

Table 7.5.1 A-3: Test parameters for Adjacent channel selectivity, Case 2

Rx Parameter	Units	CA Bandwidth Class				
		B	C	D	E	F
Power per CC in Aggregated Transmission Bandwidth Configuration	dBm		-47.5			
$P_{Interferer}$	dBm	-25				
$BW_{Interferer}$	MHz		5			
$F_{Interferer}$ (offset)	MHz		2.5+ F_{offset} / -2.5- F_{offset}			
Note 1: The transmitter shall be set to 24dB below P_{CMAX_L} at the minimum uplink configuration specified in Table 7.3.1-2 with P_{CMAX_L} as defined in clause 6.2.5A. Note 1: The interferer consists of the Reference measurement channel specified in Annex 3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1 and set-up according to Annex C.3.1 Note 1: 5. The $F_{interferer}$ (offset) is relative to the center frequency of the adjacent CC being tested and shall be further adjusted to $\lfloor F_{interferer}/0.015+0.5 \rfloor 0.015+0.0075$ MHz to be offset from the sub-carrier raster.						

For the UE that supports inter band CA with a single uplink in one band, the adjacent channel requirements are defined with the single uplink active on the band other than is the band whose downlink is being tested.

The UE shall meet the requirements specified in chapter 7.5.1 for each component carrier while both downlink carriers are active.

7.5.1B Minimum requirements for UL-MIMO

For UE(s) with two transmitter antenna connectors in closed-loop spatial multiplexing scheme, the minimum requirements in Clause 7.5.1 shall be met with the UL-MIMO configurations specified in Table 6.2.2B-2. For UL-MIMO, the parameter P_{CMAX_L} is defined as the total transmitter power over the two transmit antenna connectors.

7.6 Blocking characteristics

The blocking characteristic is a measure of the receiver's ability to receive a wanted signal at its assigned channel frequency in the presence of an unwanted interferer on frequencies other than those of the spurious response or the adjacent channels, without this unwanted input signal causing a degradation of the performance of the receiver beyond a specified limit. The blocking performance shall apply at all frequencies except those at which a spurious response occur.

7.6.1 In-band blocking

In-band blocking is defined for an unwanted interfering signal falling into the UE receive band or into the first 15 MHz below or above the UE receive band at which the relative throughput shall meet or exceed the minimum requirement for the specified measurement channels..

7.6.1.1 Minimum requirements

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Tables 7.6.1.1-1 and 7.6.1.1-2.

Table 7.6.1.1-1: In band blocking parameters

Rx Parameter	**Units**	**Channel bandwidth**					
		1.4 MHz	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
Power in Transmission Bandwidth Configuration	dBm	REFSENS + channel bandwidth specific value below					
		6	6	6	6	7	9
$BW_{Interferer}$	MHz	1.4	3	5	5	5	5
$F_{Ioffset, case 1}$	MHz	2.1+0.0125	4.5+0.0075	7.5+0.0125	7.5+0.0025	7.5+0.0075	7.5+0.0125
$F_{Ioffset, case 2}$	MHz	3.5+0.0075	7.5+0.0075	12.5+0.0075	12.5+0.0125	12.5+0.0025	12.5+0.0075

Note 1: The transmitter shall be set to 4dB below P_{CMAX_L} at the minimum uplink configuration specified in Table 7.3.1-2 with P_{CMAX_L} as defined in clause 6.2.5.

Note 2: The interferer consists of the Reference measurement channel specified in Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1 and set-up according to Annex C.3.1

Table 7.6.1.1-2: In-band blocking

E-UTRA band	Parameter	Unit	Case 1	Case 2	Case 3	Case 4
	$P_{Interferer}$	dBm	-56	-44	-30	[-30]
	$F_{Interferer}$ (offset)	MHz	$=-BW/2 - F_{Ioffset,case 1}$ & $=+BW/2 + F_{Ioffset,case 1}$	$\leq -BW/2 - F_{Ioffset,case 2}$ & $\geq +BW/2 + F_{Ioffset,case 2}$	-BW/2 – 15 & -BW/2 – 9	-BW/2 – 10
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 18, 19, 20, 21, 23, 25, 33,34,35, 36,37,38,39, 40,41	$F_{Interferer}$	MHz	(Note 2)	F_{DL_low} – 15 to F_{DL_high} + 15		
12	$F_{Interferer}$	MHz	(Note 2)	F_{DL_low} – 10 to F_{DL_high} + 15		F_{DL_low} – 10
17	$F_{Interferer}$	MHz	(Note 2)	F_{DL_low} – 9 to F_{DL_high} + 15	F_{DL_low} – 15 and F_{DL_low} – 9	
Note 1: For certain bands, the unwanted modulated interfering signal may not fall inside the UE receive band, but within the first 15 MHz below or above the UE receive band Note 2: For each carrier frequency the requirement is valid for two frequencies: a. the carrier frequency $-BW/2 - F_{Ioffset, case 1}$ and b. the carrier frequency $+BW/2 + F_{Ioffset, case 1}$ Note 3: $F_{Interferer}$ range values for unwanted modulated interfering signal are interferer center frequencies Note 4: Case 3 and Case 4 only apply to assigned UE channel bandwidth of 5 MHz						

For the UE which supports inter band CA configuration in Table 7.3.1A-2 , $P_{Interferer}$ power defined in table 7.6.1.1-2 is increased by the amount given by ΔR_{IB} in Table 7.3.1A-2.

7.6.1.1A Minimum requirements for CA

For intra-band contiguous CA (bandwidth Class C) the downlink Secondary CC shall be configured at nominal channel spacing to the Primary CC with the Primary CC configured closest the uplink band. Downlink Primary CC and Secondary CC are both activated. The uplink output power shall be set as specified in Table 7.6.1.1A-1 with the uplink configuration according to Table 7.3.1A-1 for the applicable CA Band. For UE(s) supporting one uplink, the uplink configuration of the Primary CC shall be in accordance with Table 7.3.1.

The UE shall fulfil the minimum requirement in presence of an interfering signal specified in Tables 7.6.1.1A-1 and Tables 7.6.1.1A-2 being on either side of the aggregated signal. The throughput of each carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Tables 7.6.1.1A-1 and 7.6.1.1A-2.

Table 7.6.1.1A-1: In band blocking parameters

Rx Parameter	Units	CA Bandwidth Class				
		B	C	D	E	F
Power per CC in Aggregated Transmission Bandwidth Configuration	dBm	REFSENS + CA Bandwidth Class specific value below				
			12			
$BW_{Interferer}$	MHz		5			
$F_{Ioffset, case 1}$	MHz		7.5			
$F_{Ioffset, case 2}$	MHz		12.5			
Note 1: The transmitter shall be set to 4dB below P_{CMAX_L} as defined in clause 6.2.5A Note 2: The interferer consists of the Reference measurement channel specified in Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1 and set-up according to Annex C.3.1						

Table 7.6.1.1A-2: In-band blocking

CA operating band	Parameter	Unit	Case 1	Case 2
	$P_{Interferer}$	dBm	-56	-44
	$F_{Interferer}$	MHz	=-F_{offset}– $F_{Ioffset,case\ 1}$ & =+F_{offset} + $F_{Ioffset,case\ 1}$	≤-F_{offset}– $F_{Ioffset,case\ 2}$ & ≥+F_{offset} + $F_{Ioffset,case\ 2}$
CA_1C, CA_40C	$F_{Interferer}$ (Range)	MHz	(Note 2)	F_{DL_low}– 15 to F_{DL_high}+ 15
Note 1: For certain bands, the unwanted modulated interfering signal may not fall inside the UE receive band, but within the first 15 MHz below or above the UE receive band Note 2: For each carrier frequency the requirement is valid for two frequencies: a. the carrier frequency -BW/2 - $F_{Ioffset,\ case\ 1}$ and b. the carrier frequency +BW/2 + $F_{Ioffset,\ case\ 1}$ Note 3: F_{offset} is the frequency offset from the center frequency of the adjacent CC being tested to the edge of aggregated channel bandwidth. Note 4: The $F_{interferer}$ (offset) is relative to the center frequency of the adjacent CC being tested and shall be further adjusted to $\lfloor F_{interferer}/0.015+0.5 \rfloor 0.015+0.0075$ MHz to be offset from the sub-carrier raster.				

For the UE that supports inter band CA with a single uplink in one band the in-band blocking requirements are defined with the single uplink active on the band other than is the band whose downlink is being tested. The UE shall meet the requirements specified in chapter 7.6.1.1 for each component carrier while both downlink carriers are active.

For the UE which supports inter band CA configuration in Table 7.3.1A-2 , $P_{Interferer}$ power defined in table 7.6.1.1-2 is increased by the amount given by ΔR_{IB} in Table 7.3.1A-2.

7.6.2 Out-of-band blocking

Out-of-band band blocking is defined for an unwanted CW interfering signal falling more than 15 MHz below or above the UE receive band. For the first 15 MHz below or above the UE receive band the appropriate in-band blocking or adjacent channel selectivity in sub-clause 7.5.1 and sub-clause 7.6.1 shall be applied.

7.6.2.1 Minimum requirements

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Tables 7.6.2.1-1 and 7.6.2.1-2.

For Table 7.6.2.1-2 in frequency range 1, 2 and 3, up to $\max(24,\ 6\cdot\lceil N_{RB}/6\rceil)$ exceptions are allowed for spurious response frequencies in each assigned frequency channel when measured using a 1MHz step size, where N_{RB} is the number of resource blocks in the downlink transmission bandwidth configuration (see Figure 5.4.2-1). For these exceptions the requirements of clause 7.7 Spurious response are applicable.

For Table 7.6.2.1-2 in frequency range 4, up to $\max(8,\ \lceil (N_{RB}+2\cdot L_{CRBs})/8\rceil)$ exceptions are allowed for spurious response frequencies in each assigned frequency channel when measured using a 1MHz step size, where N_{RB} is the number of resource blocks in the downlink transmission bandwidth configurations (see Figure 5.4.2-1) and L_{CRBs} is the number of resource blocks allocated in the uplink. For these exceptions the requirements of clause 7.7 spurious response are applicable.

Table 7.6.2.1-1: Out-of-band blocking parameters

Rx Parameter	Units	Channel bandwidth					
		1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Power in Transmission Bandwidth	dBm	REFSENS + channel bandwidth specific value below					
		6	6	6	6	7	9

Configuration							
Note 1: The transmitter shall be set to 4dB below P_{CMAX_L} at the minimum uplink configuration specified in Table 7.3.1-2 with P_{CMAX_L} as defined in clause 6.2.5. Note 2: Reference measurement channel is specified in Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.							

Table 7.6.2.1-2: Out of band blocking

E-UTRA band	Parameter	Units	Frequency			
			range 1	range 2	range 3	range 4
	$P_{Interferer}$	dBm	-44	-30	-15	-15
1, 2, 3, 4, 5 6, 7, 8, 9, 10, 11, 12, 13, 17, 18, 19, 20, 21, 23, 24, 25, 33,34, 35, 36, 37, 38, 39, 40, 41, 42, 43	$F_{Interferer}$ (CW)	MHz	F_{DL_low} -15 to F_{DL_low} -60	F_{DL_low} -60 to F_{DL_low} -85	F_{DL_low} -85 to 1 MHz	-
			F_{DL_high} +15 to F_{DL_high} + 60	F_{DL_high} +60 to F_{DL_high} +85	F_{DL_high} +85 to +12750 MHz	-
2, 5, 12, 17	$F_{Interferer}$	MHz	-	-	-	F_{UL_low} - F_{UL_high}
Note: For the UE which supports both Band 11 and Band 21 the out of blocking is FFS.						

7.6.2.1A Minimum requirements for CA

For intra-band contiguous CA (bandwidth Class C) the downlink Secondary CC shall be configured at nominal channel spacing to the Primary CC with the Primary CC configured closest the uplink band. Downlink Primary CC and Secondary CC are both activated.The uplink output power shall be set as specified in Table 7.6.2.1A-1 with the uplink configuration according to Table 7.3.1A-1 for the applicable CA Band. For UE(s) supporting one uplink, the uplink configuration of the Primary CC shall be in accordance with Table 7.3.1.

The UE shall fulfil the minimum requirement in presence of an interfering signal specified in Tables 7.6.2.1A-1 and Tables 7.6.2.1A-2 being on either side of the aggregated signal. The throughput of each carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Tables 7.6.1.1A-1 and 7.6.1.1A-2.

For Table 7.6.2.1A-2 in frequency range 1, 2 and 3, up to $\max\left(24,\ 6\cdot\left\lceil N_{RB,agg}/6\right\rceil\right)$ exceptions are allowed for spurious response frequencies in each assigned frequency channel when measured using a 1MHz step size, where $N_{RB,agg}$ is the number of aggregated resource blocks in the downlink transmission bandwidth configuration. For these exceptions the requirements of clause 7.7 Spurious response are applicable.

For Table 7.6.2.1A-2 in frequency range 4, up to $\max\left(8,\ \left\lceil (N_{RB,agg}+2\cdot L_{CRBs})/8\right\rceil\right)$ exceptions are allowed for spurious response frequencies in each assigned frequency channel when measured using a 1MHz step size, where $N_{RB,agg}$ is the number of aggregated resource blocks in the downlink transmission bandwidth configurations and L_{CRBs} is the number of resource blocks allocated in the uplink. For these exceptions the requirements of clause 7.7 spurious response are applicable.

Table 7.6.2.1A-1: Out-of-band blocking parameters

Rx Parameter	Units	CA Bandwidth Class				
		B	C	D	E	F
Power per CC in Aggregated Transmission Bandwidth Configuration	dBm	REFSENS + CA Bandwidth Class specific value below				
			9			

Note 1:	The transmitter shall be set to 4dB below P_{CMAX_L} at the minimum uplink configuration specified in TS 36.101 Table 7.3.1A-1, with P_{CMAX_L} as defined in clause 6.2.5A.
Note 2:	Reference measurement channel is specified in Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.

Table 7.6.2.1A-2: Out of band blocking

CA operating band	Parameter	Units	Frequency		
			range 1	range 2	range 3
	$P_{Interferer}$	dBm	-44	-30	-15
CA_1C, CA_40C	$F_{Interferer}$ (CW)	MHz	F_{DL_low} -15 to F_{DL_low} -60	F_{DL_low} -60 to F_{DL_low} -85	F_{DL_low} -85 to 1 MHz
			F_{DL_high} +15 to F_{DL_high} + 60	F_{DL_high} +60 to F_{DL_high} +85	F_{DL_high} +85 to +12750 MHz

For the UE that supports inter band CA, the out-of-bank blocking requirements are FFS.

7.6.3 Narrow band blocking

This requirement is measure of a receiver's ability to receive a E-UTRA signal at its assigned channel frequency in the presence of an unwanted narrow band CW interferer at a frequency, which is less than the nominal channel spacing.

7.6.3.1 Minimum requirements

The relative throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Table 7.6.3.1-1

Table 7.6.3.1-1: Narrow-band blocking

Parameter	Unit	Channel Bandwidth					
		1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
P_w	dBm	$P_{REFSENS}$ + channel-bandwidth specific value below					
		22	18	16	13	14	16
P_{uw} (CW)	dBm	-55	-55	-55	-55	-55	-55
F_{uw} (offset for Δf = 15 kHz)	MHz	0.9075	1.7025	2.7075	5.2125	7.7025	10.2075
F_{uw} (offset for Δf = 7.5 kHz)	MHz						
Note 1: The transmitter shall be set a 4 dB below P_{CMAX_L} at the minimum uplink configuration specified in Table 7.3.1-2 with P_{CMAX_L} as defined in clause 6.2.5.							
Note 2: Reference measurement channel is specified in Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1.							

For the UE which supports inter-band CA configuration in Table 7.3.1A-2 , P_{UW} power defined in table 7.6.3.1-1 is increased by the amount given by ΔR_{IB} in Table 7.3.1A-2.

7.6.3.1A Minimum requirements for CA

For intra-band contiguous CA (bandwidth Class C) the downlink Secondary CC shall be configured at nominal channel spacing to the Primary CC with the Primary CC configured closest the uplink band. Downlink Primary CC and Secondary CC are both activated. The uplink output power shall be set as specified in Table 7.6.3.1A-1 with the uplink configuration according to Table 7.3.1A-1 for the applicable CA Band. For UE(s) supporting one uplink, the uplink configuration of the Primary CC shall be in accordance with Table 7.3.1.

The UE shall fulfil the minimum requirement in presence of an interfering signal specified in Table 7.6.3.1A-1 being on either side of the aggregated signal. The throughput of each carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Tables 7.6.1.1A-1 and 7.6.1.1A-2.

Table 7.6.3.1A-1: Narrow-band blocking

Parameter	Unit	CA Bandwidth Class				
		B	C	D	E	F
Power per CC in Aggregated TransmissionBandwidth Configuration	dBm	REFSENS + CABandwidth Class specific value below				
			[19]			
P_{uw} (CW)	dBm		-55			
F_{uw} (offset for Δf = 15 kHz)	MHz		- F_{offset} – 0.2 / + F_{offset} + 0.2			
F_{uw} (offset for Δf = 7.5 kHz)	MHz					

Note 1: The transmitter shall be set to 4dB below P_{CMAX_L} at the minimum uplink configuration specified in TS 36.101 Table 7.3.1A-1, with P_{CMAX_L} as defined in clause 6.2.5A.
Note 2: Reference measurement channel is specified in Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1.
Note 3: The $F_{interferer}$ (offset) is relative to the center frequency of the adjacent CC being tested and shall be further adjusted to $\lfloor F_{interferer}/0.015+0.5 \rfloor 0.015+0.0075$ MHz to be offset from the sub-carrier raster.

For the UE that supports inter-band CA with a single uplink in one band the narrow-band blocking requirements are defined with the single uplink active on the band other than is the band whose downlink is being tested. The UE shall meet the requirements specified in chapter 7.6.3.1 for each component carrier while both downlink carriers are active.

7.6A Void

<Reserved for future use>

7.6B Blocking characteristics for UL-MIMO

For UE with two transmitter antenna connectors in closed-loop spatial multiplexing scheme, the minimum requirements in Clause 7.6 shall be met with the UL-MIMO configurations specified in Table 6.2.2B-2. For UL-MIMO, the parameter P_{CMAX_L} is defined as the total transmitter power over the two transmit antenna connectors.

7.7 Spurious response

Spurious response is a measure of the receiver's ability to receive a wanted signal on its assigned channel frequency without exceeding a given degradation due to the presence of an unwanted CW interfering signal at any other frequency at which a response is obtained i.e. for which the out of band blocking limit as specified in sub-clause 7.6.2 is not met.

7.7.1 Minimum requirements

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Tables 7.7.1-1 and 7.7.1-2.

Table 7.7.1-1: Spurious response parameters

Rx Parameter	Units	Channel bandwidth					
		1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Power in Transmission Bandwidth Configuration	dBm	REFSENS + channel bandwidth specific value below					
		6	6	6	6	7	9

Note:

1. The transmitter shall be set to 4dB below P_{CMAX_L} at the minimum uplink configuration specified in Table 7.3.1-2.
2. Reference measurement channel is specified in Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1.

Table 7.7.1-2: Spurious Response

Parameter	Unit	Level
$P_{Interferer}$ (CW)	dBm	-44
$F_{Interferer}$	MHz	Spurious response frequencies

For the UE which supports inter-band CA configuration in Table 7.3.1A-2, $P_{interferer}$ power defined in table 7.7.1-2 is increased by the amount given by ΔR_{IB} in Table 7.3.1A-2.

7.7.1A Minimum requirements for CA

For intra-band contiguous CA the throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Tables 7.7.1-1A and 7.7.1-2A.

Table 7.7.1A-1: Spurious response parameters

Rx Parameter	Units	CA Bandwidth Class				
		B	C	D	E	F
Power per CC in Aggregated Transmission Bandwidth Configuration	dBm	REFSENS + CA Bandwidth Class specific value below				
			9			
Note 1: The transmitter shall be set to 4dB below P_{CMAX_L} at the minimum uplink configuration specified in TS 36.101 Table 7.3.1A-1, with P_{CMAX_L} as defined in clause 6.2.5A. Note 2: Reference measurement channel is specified in Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1.						

Table 7.7.1A-2: Spurious Response

Parameter	Unit	Level
$P_{Interferer}$ (CW)	dBm	-44
$F_{Interferer}$	MHz	Spurious response frequencies

For the UE that supports inter-band CA with a single uplink in one band the spurious response requirements are defined with the single uplink active on the band other than is the band whose downlink is being tested. The UE shall meet the requirements specified in chapter 7.7.1 for each component carrier while both downlink carriers are active.

7.7.1B Minimum requirements for UL-MIMO

For UE with two transmitter antenna connectors in closed-loop spatial multiplexing scheme, the minimum requirements in Clause 7.7.1 shall be met with the UL-MIMO configurations specified in Table 6.2.2B-2. For UL-MIMO, the parameter P_{CMAX_L} is defined as the total transmitter power over the two transmit antenna connectors.

7.8 Intermodulation characteristics

Intermodulation response rejection is a measure of the capability of the receiver to receiver 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.

7.8.1 Wide band intermodulation

The wide band intermodulation requirement is defined following the same principles using modulated E-UTRA carrier and CW signal as interferer.

7.8.1.1 Minimum requirements

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Table 7.8.1.1 for the specified wanted signal mean power in the presence of two interfering signals

Table 7.8.1.1-1: Wide band intermodulation

Rx Parameter	Units	Channel bandwidth					
		1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Power in Transmission Bandwidth Configuration	dBm	REFSENS + channel bandwidth specific value below					
		12	8	6	6	7	9
$P_{Interferer\ 1}$ (CW)	dBm	-46					
$P_{Interferer\ 2}$ (Modulated)	dBm	-46					
$BW_{Interferer\ 2}$		1.4	3	5			
$F_{Interferer\ 1}$ (Offset)	MHz	-BW/2 –2.1 / +BW/2+ 2.1	-BW/2 – 4.5 / +BW/2 + 4.5	-BW/2 – 7.5 / +BW/2 + 7.5			
$F_{Interferer\ 2}$ (Offset)	MHz	2*$F_{Interferer\ 1}$					

Note:

1 The transmitter shall be set to 4dB below P_{CMAX_L} at the minimum uplink configuration specified in Table 7.3.1-2 with P_{CMAX_L} as defined in clause 6.2.5.

2 Reference measurement channel is specified in Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1.

3 The modulated interferer consists of the Reference measurement channel specified in Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1 with set-up according to Annex C.3.1The interfering modulated signal is 5MHz E-UTRA signal as described in Annex D for channel bandwidth ≥5MHz

For the UE which supports inter band CA configuration in Table 7.3.1A-2 , $P_{interferer1}$ and $P_{interferer2}$ powers defined in table 7.8.1.1-1 are increased by the amount given by ΔR_{IB} in Table 7.3.1A-2.

7.8.1A Minimum requirements for CA

For intra-band contiguous CA (bandwidth Class C) the downlink Secondary CC shall be configured at nominal channel spacing to the Primary CC with the Primary CC configured closest the uplink band. Downlink Primary CC and Secondary CC are both activated. The uplink output power shall be set as specified in Table 7.8.1.1A-1 with the uplink configuration according to Table 7.3.1A-1 for the applicable CA Band. For UE(s) supporting one uplink, the uplink configuration of the Primary CC shall be in accordance with Table 7.3.1.

The UE shall fulfil the minimum requirement in presence of an interfering signal specified in Table 7.8.1.1A-1 being on either side of the aggregated signal.The throughput of each carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Tables 7.8.1.1A-1

Table 7.8.1.1A-1: Wide band intermodulation

Rx Parameter	Units	CA Bandwidth Class				
		B	C	D	E	F
Power per CC in Aggregated Transmission Bandwidth Configuration	dBm	REFSENS + CA Bandwidth Class specific value below				
			12			

$P_{Interferer\ 1}$ (CW)	dBm	-46				
$P_{Interferer\ 2}$ (Modulated)	dBm	-46				
$BW_{Interferer\ 2}$	MHz		5			
$F_{Interferer\ 1}$ (Offset)	MHz		$-F_{offset}$-7.5 / + F_{offset}+7.5			
$F_{Interferer\ 2}$ (Offset)	MHz	2*$F_{Interferer\ 1}$				
Note 1: The transmitter shall be set to 4dB below P_{CMAX_L} at the minimum uplink configuration specified in Table 7.3.1A-1 with P_{CMAX_L} as defined in clause 6.2.5A. Note 2: Reference measurement channel is specified in Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1. Note 3: The modulated interferer consists of the Reference measurement channel specified in Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1 with set-up according to Annex C.3.1The interfering modulated signal is 5MHz E-UTRA signal as described in Annex D for channel bandwidth ≥5MHz						

For the UE that supports inter-band CA with a single uplink in one band the wide band intermodulation requirements are defined with the single uplink active on the band other than is the band whose downlink is being tested. The UE shall meet the requirements specified in chapter 7.8.1.1 for each component carrier while both downlink carriers are active.

7.8.1B Minimum requirements for UL-MIMO

For UE(s) with two transmitter antenna connectors in closed-loop spatial multiplexing scheme, the minimum requirements in Clause 7.8.1 shall be met with the UL-MIMO configurations specified in Table 6.2.2B-2. For UL-MIMO, the parameter P_{CMAX_L} is defined as the total transmitter power over the two transmit antenna connectors.

7.8.2 Void

7.9 Spurious emissions

The spurious emissions power is the power of emissions generated or amplified in a receiver that appear at the UE antenna connector.

7.9.1 Minimum requirements

The power of any narrow band CW spurious emission shall not exceed the maximum level specified in Table 7.9.1-1

Table 7.9.1-1: General receiver spurious emission requirements

Frequency Band	Measurement Bandwidth	Maximum level	Note
30MHz ≤ f < 1GHz	100 kHz	-57 dBm	
1GHz ≤ f ≤ 12.75 GHz	1 MHz	-47 dBm	

7.10 Receiver image

7.10.1 Void

7.10.1A Minimum requirements for CA

Receiver image rejection is a measure of a receiver's ability to receive the E-UTRA signal on one component carrier while it is also configured to receive an adjacent aggregated carrier. Receiver image rejection ratio is the ratio of the wanted received power on a sub-carrier being measured to the unwanted image power received on the same sub-carrier when both sub-carriers are received with equal power at the UE antenna connector.

For intra-band contiguous carrier aggregation the UE shall fulfil the minimum requirement specified in Table 7.10.1A-1 for all values of aggregated input signal up to –22 dBm. This requirement does not need to be tested.

Table 7.10.1A-1: Receiver Image Rejection

	CA Bandwidth Class						
Rx Parameter	**Units**	**A**	**B**	**C**	**D**	**E**	**F**
Receiver image rejection	dB			25			

Annex E (normative): Environmental conditions

E.1 General

This normative annex specifies the environmental requirements of the UE. Within these limits the requirements of the present documents shall be fulfilled.

E.2 Environmental

The requirements in this clause apply to all types of UE(s).

E.2.1 Temperature

The UE shall fulfil all the requirements in the full temperature range of:

Table E.2.1-1

+15°C to +35°C	for normal conditions (with relative humidity of 25 % to 75 %)
-10°C to +55°C	for extreme conditions (see IEC publications 68-2-1 and 68-2-2)

Outside this temperature range the UE, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in clause 6.2 for extreme operation.

E.2.2 Voltage

The UE shall fulfil all the requirements in the full voltage range, i.e. the voltage range between the extreme voltages.

The manufacturer shall declare the lower and higher extreme voltages and the approximate shutdown voltage. For the equipment that can be operated from one or more of the power sources listed below, the lower extreme voltage shall not be higher, and the higher extreme voltage shall not be lower than that specified below.

Table E.2.2-1

Power source	Lower extreme voltage	Higher extreme voltage	Normal conditions voltage
AC mains	0,9 * nominal	1,1 * nominal	nominal
Regulated lead acid battery	0,9 * nominal	1,3 * nominal	1,1 * nominal
Non regulated batteries: Leclanché Lithium Mercury/nickel & cadmium	 0,85 * nominal 0,95 * nominal 0,90 * nominal	 Nominal 1,1 * Nominal	 Nominal 1,1 * Nominal Nominal

Outside this voltage range the UE if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in clause 6.2 for extreme operation. In particular, the UE shall inhibit all RF transmissions when the power supply voltage is below the manufacturer declared shutdown voltage.

E.2.3 Vibration

The UE shall fulfil all the requirements when vibrated at the following frequency/amplitudes.

Table E.2.3-1

Frequency	ASD (Acceleration Spectral Density) random vibration
5 Hz to 20 Hz	0,96 m^2/s^3
20 Hz to 500 Hz	0,96 m^2/s^3 at 20 Hz, thereafter –3 dB/Octave

Outside the specified frequency range the UE, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in TS 36.101 for extreme operation.

Annex Z: Change history

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
03-2010	RAN4#54	R4-101051			TRab.cde proposal for UE rel10 (CA, DL MA, UL MA and CPE)		0.0.0
03-2010	RAN4#54	R4-100755			TP for section 6-7 for TRab.cde_ UE Rel-10		
03-2010	RAN4#54	R4-101062			TP; Section 8; TRab.cde UE Rel 10		
03-2010	RAN4#54	R4-101067			TP; Annex A; TRab.cde UE Rel 10		
03-2010	RAN4#54	R4-101071			TRab.cde proposal for UE rel10 (CA, DL MA, UL MA and CPE)	0.0.0	0.0.1
05-2010	RAN4#55	R4-101402			TP for section 4 (General) and Annex B for TRab.cde	0.0.1	0.0.2
05-2010	RAN4#55	R4-101484			TP section 8 (CA scenario) for TRab.cde	0.0.1	0.0.2
07-2010	RAN4#3Ad-hoc	R4-102661			CPE TP for TR36.807	0.0.2	0.0.3
07-2010	RAN4#3Ad-hoc	R4-102726			Way forward on channel arrangements	0.0.2	0.0.3
07-2010	RAN4#3Ad-hoc	R4-102731			Text Proposal for LTE-A UE TR Clause 6.6.3: Spurious Emissions	0.0.2	0.0.3
07-2010	RAN4#3Ad-hoc	R4-102739			Way forward on carrier aggregation UE Tx RF aspect	0.0.2	0.0.3
07-2010	RAN4#3Ad-hoc	R4-102740			TP for CA UE TR: Section 5.6 CA Channel bandwidths	0.0.2	0.0.3
07-2010	RAN4#3Ad-hoc	R4-102743			TP for CA UE TR: Section 6.1 General Transmitter Characteristics	0.0.2	0.0.3
07-2010	RAN4#3Ad-hoc	R4-102745			TP for TR36.807: EVM and in-band emission	0.0.2	0.0.3
08-2010	RAN4#56	R4-102854			TP for CA UE TR: Section 3.2, 5.6 and Annex B, CA Channel BW	0.0.3	0.1.0
08-2010	RAN4#56	R4-102855			TP for CA UE TR: Section 5.7.2 CA Channel raster	0.0.3	0.1.0
08-2010	RAN4#56	R4-102858			TP for CA UE TR: Section 5.5 CA operating bands	0.0.3	0.1.0
08-2010	RAN4#56	R4-102930			TP for TX-RX frequency separation in CA	0.0.3	0.1.0
08-2010	RAN4#56	R4-103393			CA Classes	0.0.3	0.1.0
08-2010	RAN4#56	R4-103446			TP for CA MIN and OFF power	0.0.3	0.1.0
08-2010	RAN4#4	R4-103913			TP for CA UE (OBW)	0.1.0	0.2.0
08-2010	RAN4#4	R4-103964			TP for TR 36.807: E-UTRA intra-band CA channel arrangement, SEM and ACLR	0.1.0	0.2.0
08-2010	RAN4#4	R4-103973			TP for CA UE TR: Section 5.6, 5.6.1 and Annex B section 5.6.1 conditional DL CC symmetry	0.1.0	0.2.0
08-2010	RAN4#4	R4-103976			TP on UE CA frequency error	0.1.0	0.2.0
08-2010	RAN4#4	R4-103552			TP for CA UE TR general requirements	0.1.0	0.2.0
08-2010	RAN4#4	R4-103851			TP on UE CA Receiver spurious emissions	0.1.0	0.2.0
11-2010	RAN4#57	R4-104122			TP on UE Maximum Input Level	0.2.0	1.0.0
11-2010	RAN4#57	R4-104164			TP on channel spacing for TR36.807	0.2.0	1.0.0
11-2010	RAN4#57	R4-104335			TP for CA UE TR: MPR	0.2.0	1.0.0
11-2010	RAN4#57	R4-104336			TP for CA UE TR: ACLR	0.2.0	1.0.0
11-2010	RAN4#57	R4-104445			TP for TR 36.807: updates to spectral emission mask for intra-band CA	0.2.0	1.0.0
11-2010	RAN4#57	R4-104601			TP for Corrections of E-UTRA updates (TR 36.807 clause 6)	0.2.0	1.0.0
11-2010	RAN4#57	R4-104778			TP for TR 36.807: number of CC(s) per CA Bandwidth Class and channel arrangement for UL MIMO	0.2.0	1.0.0
1-2011	RAN4#57AH	R4-110497			TR36.807 v1.1.0	1.0.0	1.1.0
11-2010	RAN4#57	R4-104253			Text proposal to TR36.807 for CPE to E-UTRA BS coexistence studies	1.1.0	1.2.0
1-2011	RAN4#57AH	R4-110486			Channel bandwidths per operating band for UL-MIMO	1.1.0	1.2.0
1-2011	RAN4#57AH	R4-110117			TP for UL-MIMO: Power Control	1.1.0	1.2.0
1-2011	RAN4#57AH	R4-110485			TP for UL-MIMO TR Clause 7.3 Refsens Level & Clause 7.4 Maximum input level	1.1.0	1.2.0
1-2011	RAN4#57AH	R4-110126			TP for UL-MIMO TR Clause 7.5 ACS	1.1.0	1.2.0
1-2011	RAN4#57AH	R4-110483			TP for UL-MIMO TR Clause 7.7 Spurious response	1.1.0	1.2.0
1-2011	RAN4#57AH	R4-110484			TP for UL-MIMO TR Clause 7.6 Blocking	1.1.0	1.2.0
1-2011	RAN4#57AH	R4-110482			TP for UL-MIMO TR Clause 7.8 Intermodulation characteristics	1.1.0	1.2.0
1-2011	RAN4#57AH	R4-110127			TP for UL-MIMO TR Clause 7.9 Spurious emissions	1.1.0	1.2.0
1-2011	RAN4#57AH	R4-110473			Correction of the formula of middle guard band size	1.1.0	1.2.0
1-2011	RAN4#57AH	R4-110514			TP on TX-RX frequency separation for CA	1.1.0	1.2.0
1-2011	RAN4#57AH	R4-110515			TP for CA UE Reference level for TR36.807	1.1.0	1.2.0
1-2011	RAN4#57AH	R4-110530			TP for CA UE TR: Section 6.5.2 Transmit modulation quality	1.1.0	1.2.0
1-2011	RAN4#57AH	R4-110505			TP for 36.807: Inter-band operating bands and Channel bandwidths	1.1.0	1.2.0
2-2011	RAN4#58	R4-110505			TP for TR 36.807 section 6.2.3 MPR for LTE multi cluster transmission	1.2.0	1.3.0
2-2011	RAN4#58	R4-111669			Analysis of the influence on the unwanted emissions for UL MIMO	1.2.0	1.3.0
2-2011	RAN4#58	R4-111629			TP for TR36.807: Section 7.5 ACS for Intra-band Contiguous CA	1.2.0	1.3.0
2-2011	RAN4#58	R4-111033			TP for CPE ACLR requirements	1.2.0	1.3.0
2-2011	RAN4#58	R4-111608			Definition of configured transmitted power for Rel-10	1.2.0	1.3.0
2-2011	RAN4#58	R4-111940			Introduction of requirement for adjacent intraband CA image rejection	1.2.0	1.3.0
2-2011	RAN4#58	R4-111512			Removal of E-UTRA ACLR for CA	1.2.0	1.3.0

2-2011	RAN4#58	R4-111296			CR: Maximum input level for intra band CA	1.2.0	1.3.0
2-2011	RAN4#58	R4-111623			TP; 36.807: Ways forward on additional insertion loss	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-111855			MPR for LTE multi cluster transmission	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-111966			Removal of FFS from channel bandwidths per operating band for CA	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-112253			Correction of requirement for adjacent intraband CA image rejection	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-112275			CR to correct OOB and emission domain requirements	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-112343			TP for TR 36.807, Annex B for Pcmax,c and Pcmax for CA	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-112321			Interband CA framework	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-111969			TP to TR36.807 on Section 6.1 General for UL-MIMO transmitter requirements	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-111970			TP for UL-MIMO transmitter requirements on Section 6.2.2B for UE Maximum Output Power	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-112344			TP for Section 6.3.2B Minimum output power for UL-MIMO transmitter requirements	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-11975			TP for Section 6.3.3B UE OFF power for UL-MIMO transmitter requirements	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-11976			TP for Section 6.3.4B UE ON/OFF time mask for UL-MIMO transmitter requirements	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-111826			TP for TR36.807 : ON/OFF time mask (not Annex B part)	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-11978			TP for Section 6.5.1B Frequency Error for UL-MIMO transmitter	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-112226			TP on Section 6.5.2B on Transmit modulation quality for UL-MIMO	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-112227			Draft] TP for UL-MIMO transmitter requirements	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-119181			TP for UL-MIMO transmitter requirements	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-119182			TP for UL-MIMO Spurious emission requirements	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-119183			TP for UL-MIMO transmitter requirements	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-119184			TP on Section 7.1: General section with UL-MIMO requirements supported	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-119185			TP on Section 7.3.1B UE REFSENS Level for UL-MIMO	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-119186			TP for UL-MIMO Maximum input level	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-119187			TP for UL-MIMO receiver requirements	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-119188			TP for UL-MIMO Blocking requirements	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-119189			TP for UL-MIMO Blocking requirements	1.3.0	1.4.0
4-2011	RAN4#58AH	R4-119190			TP for Section 7.8.1B UL-MIMO Intermodulation requirements	1.3.0	1.4.0
5-2011	RAN4#59	R4-112891			Transmit intermodulation for Intra-band Contiguous CA	1.4.0	1.5.0
5-2011	RAN4#59	R4-112940			Discussion on CA UE time mask requirements	1.4.0	1.5.0
5-2011	RAN4#59	R4-113085			Intra-band contiguous CA RX requirements	1.4.0	1.5.0
5-2011	RAN4#59	R4-112780			UL-MIMO MPR	1.4.0	1.5.0
5-2011	RAN4#59	R4-112781			UL-MIMO A-MPR	1.4.0	1.5.0
5-2011	RAN4#59	R4-113147			UL-MIMO Configured output power	1.4.0	1.5.0
4-2011	RAN4#58AH	R4-112305			TP for UL-MIMO: Time Alignment Error (TAE) between Transmit Antenna Connectors	1.4.0	1.5.0
4-2011	RAN4#58AH	R4-112977			Email discussion on TIB,c applicability summary and TP for TR 36.807 v.1.4.0, Annex B for Pcmax,c and Pcmax or CA with the inter-band case Pcmax,c_L equations corrected	1.4.0	1.5.0
4-2011	RAN4#58AH	R4-113152			Scc allocation size for CA_1C	1.4.0	1.5.0
4-2011	RAN4#58AH	R4-113187			Intra-band contiguous CA Rx requirements	1.4.0	1.5.0
6-2011	RAN4#59AH	R4-113290			TP for TR 36.807: handling of inter-band CA scenarios	1.5.0	1.6.0
6-2011	RAN4#59AH	TS36.101			Update of Annex B with 2011- June release of TS36.101v.10.3.0 (sections 2, 3, 4, 5, 6 and 7	1.5.0	1.6.0
08-2011	RAN4#60	R4-114464			Adding the operating bands for UL-MIMO	1.6.0	1.7.0
11-2011	RAN4#61	R4-116210			TP for MPR mask of multi-cluster simultaneous transmission for LTE-A	1.6.0	1.7.0
06-2012	RAN#56	RP-120706			Presentation of TR 36.808 to TSG RAN#56 for approval	1.7.0	2.0.0
06-2012	RAN#56	RP-120706			Approved by RAN	2.0.0	10.0.0