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LTE-Advanced intra-band non-contiguous Carrier Aggregation
(CA) in Band 4
(Release 12)**



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Foreword

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

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

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- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

The present document is the technical report for the *LTE Advanced Intra-band Non-contiguous Carrier Aggregation in Band 4* work item, which was approved at TSG RAN #56 [9].

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: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception".
- [3] 3GPP TS 36.104: "Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception".
- [4] 3GPP TS 36.133: "Evolved Universal Terrestrial Radio Access (E-UTRA); Requirements for support of radio resource management".
- [5] 3GPP TS 36.141: "Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing".
- [6] 3GPP TS 36.307: "Evolved Universal Terrestrial Radio Access (E-UTRA); Requirements on User Equipments (UEs) supporting a release-independent frequency band".
- [7] 3GPP TS 37.104: "E-UTRA, UTRA and GSM/EDGE; Multi-Standard Radio (MSR) Base Station (BS) radio transmission and reception".
- [8] 3GPP TS 37.141: "E-UTRA, UTRA and GSM/EDGE; Multi-Standard Radio (MSR) Base Station (BS) conformance testing".
- [9] RP-120593, "WID LTE Advanced intra-band non-contiguous Carrier Aggregation for Band 4," T-Mobile USA.
- [10] RP-130842, "Revised WID: LTE Advanced intra-band non-contiguous Carrier Aggregation in Band 4," T-Mobile USA.

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

3.2 Symbols

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

F_{DL_high}	The highest frequency of the downlink operating band
F_{DL_low}	The lowest frequency of the downlink operating band
f_high	The highest frequency
f_low	The lowest frequency
F_{UL_high}	The highest frequency of the uplink operating band
F_{UL_low}	The lowest frequency of the uplink operating band
W_{gap}	Sub-block gap size
ΔR_{IBNC}	Allowed reference sensitivity relaxation due to support for intra-band non-contiguous CA operation

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].

CA_4-4	Intra-band non-contiguous CA in Band 4
CA_4A-4A	Intra-band non-contiguous CA in Band 4
DL	Downlink
FDD	Frequency Division Duplex
IMD	Intermodulation
PCC	Primary Component Carrier
REFSENS	Reference Sensitivity power level
UL	Uplink

4 Background

The work item intra-band non-contiguous carrier aggregation in band 4, LTE_CA_NC_B4, was first approved in RAN #56 [9]. Its scope includes both DL and UL carrier aggregation with different timescales for 1 UL and 2 UL. The scope was later revised to 1 UL only in RAN #60 [10].

4.1 Task description

The purpose and objectives of this work item are:

- Specify the band specific RF requirements for band 4 intra-band non-contiguous carrier aggregation.
- CA_4A-4A configuration will consist of aggregating DL and UL channel bandwidths of 5 MHz, 10 MHz, 15 MHz, and 20 MHz per component carrier. Up to two DL component carriers and one UL component carrier are aggregated simultaneously. All bandwidth combinations are supported by this WI.
- Add the performance requirements for this band combination in the relevant specifications.
- Add the conformance testing in RAN5 specifications (to follow).

5 Band and channel arrangement

5.1 CA Operating bands

CA_4A-4A is defined to operate in the entire frequency range of Band 4, as defined in Table 5.1-1.

Table 5.1-1: Intra-band non-contiguous CA operating band definition in Band 4

E-UTRA CA Band	E-UTRA Band	Uplink (UL) operating band			Downlink (DL) operating band			Duplex Mode
		BS receive / UE transmit			BS transmit / UE receive			
		F_{UL_low}	–	F_{UL_high}	F_{DL_low}	–	F_{DL_high}	
CA_4-4	4	1710 MHz	–	1755 MHz	2110 MHz	–	2155 MHz	FDD

5.2 CA channel bandwidth

The supported E-UTRA bandwidths for CA_4A-4A are shown in Table 5.2-1.

Table 5.2-1: Supported E-UTRA bandwidths for intra-band non-contiguous CA in Band 4

CA operating band / channel bandwidth							
E-UTRA CA Band	E-UTRA Bands	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
CA_4A-4A	4			Yes	Yes	Yes	Yes

6 E-UTRA RF requirements for UE

6.1 Transmitter characteristics

6.1.1 UL harmonics and IMD

CA_4 operates at 1710~1755 MHz for UL and 2110~2155 MHz for DL. Assuming UE transmitting in the whole range of 1710~1755 MHz, the 2nd and 3rd order of harmonics, 2nd, 3rd, 5th, and 7th order IMD are calculated and shown in the table 6.1.1.

Table 6.1.1-1: CA_4 UL harmonics and IMD

Harmonics and IMD	Frequency range in MHz	Falling into RX band?
2 nd harmonics	3420~ 3510	No
3 rd harmonics	5130~ 5265	No
2 nd order IMD	-45 ~ 45	No
3 rd order IMD (2f1-f2)	1665 ~ 1800	No
5 th order IMD (3f1-2f2)	1620 ~ 1845	No
5 th order IMD (4f1-f2)	5085 ~ 5310	No
7 th order IMD (4f1-3f2)	1575 ~ 1890	No
7 th order IMD (5f1-2f2)	5040 ~ 5355	No

The UE RX band is 2110~2155 MHz. From the above table it can be seen that the 2nd and 3rd order harmonics and the 2nd, 3rd, 5th, and 7th order IMD do not overlap with the UE RX band. So, there is no harmonics and IMD issue for intra-band non-contiguous CA_4 UE which supports 2UL.

There is no harmonics and IMD issue for intra-band non-contiguous CA_4 UE which supports 2UL.

6.2 Receiver characteristics

6.2.1 REFSSENS test

Duplex gap for band 4 is 355 MHz which is also the smallest separation distance of own PCC UL and SCC DL.

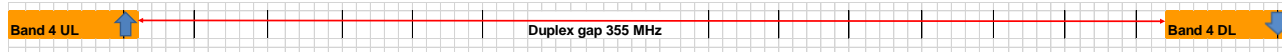


Figure 6.2.1-1 duplex gap of band 4

It is anticipated that this distance is large enough to enable full UL allocation operation during the REFSSENS test with one UL configured. Following intra-band non-contiguous CA uplink configuration for reference sensitivity for CA_4A-4A when one UL is being configured is proposed to be specified.

Table 6.2.1-1: Intra-band non-contiguous CA uplink configuration for reference sensitivity for CA_4A-4A

CA configuration	Aggregated channel bandwidth (PCC+SCC)	W _{gap} / [MHz]	PCC allocation	ΔR_{BNC} (dB)	Duplex mode
CA_4A-4A	25RB + 25RB	$W_{gap} \leq 35.0$	25^1	0.0	FDD
	25RB + 50RB	$W_{gap} \leq 30.0$	25^1	0.0	
	25RB + 75RB	$W_{gap} \leq 25.0$	25^1	0.0	
	25RB + 100RB	$W_{gap} \leq 20.0$	25^1	0.0	
	50RB + 25RB	$W_{gap} \leq 30.0$	50^1	0.0	
	50RB + 50RB	$W_{gap} \leq 25.0$	50^1	0.0	
	50RB + 75RB	$W_{gap} \leq 20.0$	50^1	0.0	
	50RB + 100RB	$W_{gap} \leq 15.0$	50^1	0.0	
	75RB + 25RB	$W_{gap} \leq 25.0$	75^1	0.0	
	75RB + 50RB	$W_{gap} \leq 20.0$	75^1	0.0	
	75RB + 75RB	$W_{gap} \leq 15.0$	75^1	0.0	
	75RB + 100RB	$W_{gap} \leq 10.0$	75^1	0.0	
	100RB + 25RB	$W_{gap} \leq 20.0$	100^1	0.0	
	100RB + 50RB	$W_{gap} \leq 15.0$	100^1	0.0	
100RB + 75RB	$W_{gap} \leq 10.0$	100^1	0.0		
100RB + 100RB	$W_{gap} \leq 5.0$	100^1	0.0		

NOTE 1: ¹ refers to the UL resource blocks shall be located as close as possible to the downlink operating band but confined within the transmission.

NOTE 2: W_{gap} is the sub-block gap between the two sub-blocks.

NOTE 3: The carrier center frequency of PCC in the UL operating band is configured closer to the DL operating band.

7 E-UTRA RRM requirements for UE

It is concluded that no change to UE RRM specifications is required.

8 E-UTRA RF requirements for BS

8.1 Co-existence studies

Table 8.1-1 shows harmonics frequency limits and Table 8.1-2 intermodulation products frequency limits for CA of Band 4, respectively.

Table 8.1-1: DL harmonics frequency limits for CA of Band 4

BS DL carriers	f_low	f_high
DL frequency (MHz)	2110	2155
2 nd order harmonics frequency range (MHz)	4220 to 4310	
3 rd order harmonics frequency range (MHz)	6330 to 6465	

As shown in Table 8.1-1, no second and no third harmonics will fall to any 3GPP UL frequencies.

Table 8.1-2: DL intermodulation products frequency limits for CA of Band 4

BS DL carriers	f_low	f_high
DL frequency (MHz)	2110	2155
2 nd order IMD products	f_low - f_high	f_high - f_low
IMD frequency range (MHz)	-45 to 45	
3 rd order IMD products	$ 2 \cdot f_{\text{low}} - f_{\text{high}} $	$ 2 \cdot f_{\text{high}} - f_{\text{low}} $
IMD frequency range (MHz)	2065 to 2200	

As shown in Table 8.1-2, no second and no third IMD products will fall to any 3GPP UL frequencies.

9 Summary of required changes to E-UTRA specifications

9.1 Required changes to TS 36.101

Required changes to TS 36.101 [2] are shown in Table 9.1-1.

Table 9.1-1: Required changes to TS 36.101 [2]

Clause	Requirement	Required changes to TS 36.101
5.5A	Operating bands for CA	A new row is to be added to Table 5.5A-3 in which requirement of CA_4A-4A operating band is provided.
5.6A.1	Channel bandwidths per operating band for CA	A new row is to be added to Table 5.6A.1-3 in which requirement of CA_4A-4A supported E-UTRA bandwidths is provided.
7.3.1A	Minimum requirements (QPSK) for CA	A new row is to be added to Table 7.3.1A-3 in which requirement of CA_4A-4A uplink configuration for reference sensitivity is provided.

9.2 Required changes to TS 36.104

Required changes to TS 36.104 [3] are shown in Table 9.2-1.

Table 9.2-1: Required changes to TS 36.104 [3]

Clause	Requirement	Required Changes to TS 36.104
5.5	Operating bands	A new row is to be added to Table 5.5-4 in which requirement of CA_4A-4A carrier aggregation band is provided.

9.3 Required changes to TS 36.133

No change is required to TS 36.133 [4].

9.4 Required changes to TS 36.141

Required changes to TS 36.141 [5] are shown in Table 9.4-1.

Table 9.4-1: Required changes to TS 36.141 [5]

Clause	Requirement	Required Changes to TS 36.141
5.5	Operating bands	A new row is to be added to Table 5.5-4 in which requirement of CA_4A-4A carrier aggregation band is provided.

9.5 Required changes to TS 36.307

Required changes to TS 36.307 [6] are shown in Table 9.5-1.

Table 9.5-1: Required changes to TS 36.307 [6]

Clause	Requirement	Required Changes to TS 36.307
TBD	CA configuration CA_4A-4A Independent of Release	A chapter is to be added in which CA_4A-4A requirement on User Equipments supporting a release-independent frequency band is provided for Rel-11 upwards.

9.6 Required changes to TS 37.104

No change is required to TS 37.104 [7].

9.7 Required changes to TS 37.141

No change is required to TS 37.141 [8].

Annex A: Change history

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
2012-10	RAN4#64-bis	R4-125017			TR 36.833-2-04 skeleton	N/A	0.0.1
2013-02	RAN4#66	R4-130014			The following TPs have been implemented: R4-126106, "Harmonics and intermodulation products generated by the BS supporting non-contiguous CA of Band 4" Editorial updates by the rapporteur: • Changed version number	0.0.1	0.1.0
2013-04	RAN4#66-bis	R4-130990			The following TPs have been implemented: R4-130193, "TP on harmonics and intermodulation products caused by intra-band non-contiguous CA_4 UE," Editorial updates by the rapporteur: • Changed version number	0.1.0	0.2.0
2013-05	RAN4#67	R4-132092			The following TPs have been implemented: • R4-131921, "UL allocation for CA 4A-4A REFSENS test with one UL" Editorial updates by the rapporteur: • Changed version number	0.2.0	0.3.0
2013-08	RAN4#68	R4-133171			Editorial updates by the rapporteur: • Clause 4, added text to Clause 4 Background and subclause 4.1 Task Description • Clause 5, added text and tables to subclauses 5.1 CA Operating bands and 5.2 CA channel bandwidth • Clause 7, added text "It is concluded that no change to UE RRM specifications is required." • Clause 9, added text and tables to subclauses 9.x Required changes to TS36.101, 104, 141, and 307 . Added text "No change is required" to subclauses 9.x Required changes to TS36.133, 37.104, and 37.141 . • Delete Clause 10 Project plan . • Change version number to 0.3.1. Update Annex A to maintain change history. • Change TR number to 36.833-2-04.	0.3.0	0.3.1
2013-09	RAN#61	RP-131137			Submitted to RAN #61 for 1-step Approval	0.3.1	1.0.0