

**3rd Generation Partnership Project;
Technical Specification Group Radio Access Network;
NR inter-band Carrier Aggregation/Dual connectivity for 2
bands DL with x bands UL (x=1, 2)
(Release 16)**



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Foreword

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1 Scope

The present document is a technical report for NR inter-band CA and DC for 2 bands DL with up to 2 bands UL under Rel-16 time frame. The purpose is to gather the relevant background information and studies in order to address NR inter-band CA and DC for 2 bands DL with up to 2 bands UL for the Rel-16 band combinations in Table 1-1 to Table 1-3

Table 1-1: Release 16 Inter-band NR CA for 2 bands DL with 1 band UL

CA combination	REL independent from
n1-n3	Rel-15
n1-n7	Rel-15
n1-n8	Rel-15
n1-n28	Rel-15
n1-n40	Rel-15
n1-n41	Rel-15
n1-n77	Rel-15
n1-n78	Rel-15
n1-n79	Rel-15
n1-n257	Rel-15
n2-n5	Rel-15
n2-n48	Rel-15
n2-n66	Rel-15
n2-n77	Rel-15
n2-n78	Rel-15
n3-n7	n3-n8
n3-n8	Rel-15
n3-n28	Rel-15
n3-n38	Rel-15
n3-n40	Rel-15
n3-n41	Rel-15
n3-n77	Rel-15
n3-n79	Rel-15
n3-n257	Rel-15
n5-n7	Rel-15
n5-n66	Rel-15
n5-n77	Rel-15
n5-n78	Rel-15
n5-n79	Rel-15
n5-n260	Rel-15
n5-n261	Rel-15
n7-n25	Rel-15
n7-n28	Rel-15
n7-n66	Rel-15
n7-n78	Rel-15
n8-n39	Rel-15
n8-n40	Rel-15
n8-n41	Rel-15
n8-n79	Rel-15
n20-n7	Rel-15
n20-n28	Rel-15
n20-n78	Rel-15
n25-n41	Rel-15
n25-n66	Rel-15
n25-n71	Rel-15
n25-n78	Rel-15
n25-n260	Rel-15
n25-n261	Rel-15
n28-n40	Rel-15
n28-n41	Rel-15
n28-n50	Rel-15
n28-n77	Rel-15
n28-n78	Rel-15
n29-n66	Rel-15
n29-n70	Rel-15
n28-n257	Rel-15
n38-n78	Rel-15
n39-n40	Rel-15
n39-n41	Rel-15
n39-n79	Rel-15
n40-n41	Rel-15
n40-n78	Rel-15

n40-n79	Rel-15
n41-n50	Rel-15
n41-n66	Rel-15
n41-n71	Rel-15
n41-n79	Rel-15
n41-n260	Rel-15
n41-n261	Rel-15
n48-n66	Rel-15
n50-n78	Rel-15
n66-n78	Rel-15
n66-n70	Rel-15
n66-n71	Rel-15
n66-n77	Rel-15
n66-n78	Rel-15
n66-n260	Rel-15
n66-n261	Rel-15
n70-n71	Rel-15
n71-n260	Rel-15
n71-n261	Rel-15
n77-n257	Rel-15
n77-n258	Rel-15
n77-n261	Rel-15
n78-n92	Rel-15
n78-n257	Rel-15
n78-n258	Rel-15
n79-n258	Rel-15

Table 1-2: Release 16 Inter-band NR CA for 2 bands DL with 2 bands UL

CA combination	REL independent from
n1-n3	Rel-15
n1-n7	Rel-15
n1-n8	Rel-15
n1-n28	Rel-15
n1-n40	Rel-15
n1-n41	Rel-15
n1-n78	Rel-15
n1-n79	Rel-15
n1-n257	Rel-15
n2-n5	Rel-15
n2-n48	Rel-15
n2-n66	Rel-15
n2-n77	Rel-15
n2-n78	Rel-15
n3-n8	Rel-15
n3-n28	Rel-15
n3-n38	Rel-15
n3-n40	Rel-15
n3-n41	Rel-15
n3-n77	Rel-15
n3-n79	Rel-15
n3-n257	Rel-15
n5-n7	Rel-15
n5-n66	Rel-15
n5-n77	Rel-15
n5-n78	Rel-15
n5-n79	Rel-15
n5-n260	Rel-15
n5-n261	Rel-15
n7-n28	Rel-15
n7-n66	Rel-15
n7-n78	Rel-15
n8-n39	Rel-15
n8-n40	Rel-15
n8-n41	Rel-15
n8-n79	Rel-15
n20-n7	Rel-15
n20-n28	Rel-15
n20-n78	Rel-15
n25-n41	Rel-15
n25-n66	Rel-15
n25-n71	Rel-15
n25-n78	Rel-15
n28-n40	Rel-15
n28-n41	Rel-15
n28-n50	Rel-15
n28-n78	Rel-15
n28-n257	Rel-15
n38-n78	Rel-15
n39-n40	Rel-15
n39-n41	Rel-15
n39-n79	Rel-15
n40-n41	Rel-15
n40-n79	Rel-15
n41-n50	Rel-15
n41-n66	Rel-15
n41-n71	Rel-15
n41-n78	Rel-15
n41-n79	Rel-15
n48-n66	Rel-15
n50-n78	Rel-15
n66-n77	Rel-15

n66-n78	Rel-15
n77-n257	Rel-15
n77-n261	Rel-15
n78-n92	Rel-15
n78-n257	Rel-15

Table 1-3: Release 16 Inter-band DC for 2 bands

DC combination	REL independent from

This TR contains a general part and band specific combination part. The actual requirements are added to the corresponding technical specifications.

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 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".
- [3] 3GPP TS 38.101-2: "NR; User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone".
- [4] 3GPP TS 38.101-3: "NR; User Equipment (UE) radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP 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 3GPP TR 21.905 [1].

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

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

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.

3.2 Symbols

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

$\Delta R_{IB,c}$	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

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP 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 3GPP TR 21.905 [1].

BS	Base Station
CA	Carrier Aggregation
DC	Dual Connectivity
DL	DownLink
FDD	Frequency Division Duplex
IMD	Inter-modulation
MSD	Maximum Sensitivity Deduction
SCS	Subcarrier spacing
TDD	Time Division Duplex
UE	User Equipment
UL	UpLink

4 Background

The present document is a technical report for NR inter-band CA and DC for 2 bands DL with up to 2 bands UL under Rel-16 time frame. It covers both the UE and BS side. The document is divided in two different parts:

- General part: this part covers BS and UE specific which is band combination independent.
- Specific band combination part: this part covers each band combination and its specific issues independently from each other (i.e. one subclause is defined per band combination)

The specific band combination parts are independent and therefore, the working speed also differs.

4.1 TR Maintenance

A single company is responsible for introducing all approved TPs in the current TR, i.e. TR editor. However, it is the responsibility of the contact person of each band combination to ensure that the TPs related to the band combination have been implemented.

5 NR Inter-Band Combination: General Part

6 Both bands within FR1 Carrier Aggregation: Specific Band Combination Part

6.1 CA_n1-n78

6.1.1 Common for 1 band UL and 2 bands UL

6.1.1.1 Operating bands for CA

Table 6.1.1.1-1: CA band combination of band n1+n78

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
	BS receive / UE transmit			BS transmit / UE receive				
	F _{UL_low}	–	F _{UL_high}	F _{DL_low}	–	F _{DL_high}		
n1	1920 MHz	–	1980 MHz	2110 MHz	–	2170 MHz	FDD	
n78	3300 MHz	–	3800 MHz	3300 MHz	–	3800 MHz	TDD	

6.1.1.2 Channel bandwidths per operating band for CA

Table 6.1.1.2-1: Supported bandwidths per CA band combination of band n1+n78

CA operating / channel bandwidth [MHz]																0
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	
CA_n1A-n78A	CA_n1A-n78A	n1	15	Yes	Yes	Yes	Yes									
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
		n78	15		Yes	Yes	Yes			Yes	Yes					
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
CA_n1A-n78(2A)	CA_n1A-n78A	n1	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
		n78	See CA_n78(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1													
CA_n1A-n78C	CA_n1A-n78A	n1	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
		n78	See CA_n78C Bandwidth Combination Set 0 in Table 5.5A.1-1 in 38.101-1													

6.1.1.3 UE co-existence studies

Table 6.1.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n1-n78.

Table 6.1.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		nth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n1	1920	1980	2110	2170	3840	3960	5760	5940		
n78	3300	3800	3300	3800	6600	7600	9900	11400		

Based on above table, there is no harmonic issue for the band combination of n1 and n78.

Table 6.1.1.3-2: Impact of UL/DL Harmonic mixing

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2nd Harmonic		3rd Harmonic		mth Harmonic	
	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n1	1920	1980	2110	2170	4220	4340	6330	6510		
n78	3300	3800	3300	3800	6600	7600	9900	11400		

Based on above table, there is no harmonic mixing issue for the band combination of n1 and n78.

6.1.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n1-n78 , the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 6.1.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n1-n78	n1	0.3
	n78	0.8

Table 6.1.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n1-n78	n1	0
	n78	0.5

6.1.1.5 REFSENS requirements

There are no specific REFSENS requirements

6.1.2 Specific for 2 bands UL CA

6.1.2.1 UE co-existence studies

Table 6.1.2.1-1 lists Band n1 +Band n78 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.1.2.1-1: Band n1 and Band n78 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	<bfy_low< b=""></bfy_low<>	fy_high
UL frequency (MHz)	1920	1980	3300	3800
2 nd order IMD products	fy_low - fx_high	fy_high - fx_low	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	1320 – 1880		5220 – 5780	
Two-tone 3 rd order IMD products	2*fx_low - fy_high	2*fx_high - fy_low	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	40 – 660		4620 – 5680	
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	7140 – 7760		8520 – 9580	
Two-tone 3 rd order IMD products	(fx_low – max BW fy)	(fx_high + max BW fy)	(fy_low – max BW fx)	(fy_high + max BW fx)
IMD frequency limits (MHz)	1820 – 2080		3280 – 3820	
Two-tone 4 th order IMD products	3*fx_low - 1*fy_high	3*fx_high - 1*fy_low	3*fy_low - 1*fx_high	3*fy_high - 1*fx_low
IMD frequency limits (MHz)	1960 – 2640		7920 – 9480	
Two-tone 4 th order IMD products	2*fx_low - 2*fy_high	2*fx_high - 2*fy_low		
IMD frequency limits (MHz)	2640 – 3760			
Two-tone 4 th order IMD products	3*fx_low + 1*fy_low	3*fx_high + 1*fy_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high
IMD frequency limits (MHz)	9060 – 9740		11820 – 13380	
Two-tone 4 th order IMD products	2*fx_low + 2*fy_low	2*fx_high + 2*fy_high		
IMD frequency limits (MHz)	10440 – 11560			
Two-tone 5 th order IMD products	fx_low - 4*fy_high	fx_high - 4*fy_low	fy_low - 4*fx_high	fy_high - 4*fx_low
IMD frequency limits (MHz)	11220 – 13280		3880 – 4620	
Two-tone 5 th order IMD products	2*fx_low - 3*fy_high	2*fx_high - 3*fy_low	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)	5940 – 7560		660 – 1840	
Two-tone 5 th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
IMD frequency limits (MHz)	15120 – 17180		10980 – 11720	
Two-tone 5 th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	13740 – 15360		12360 – 13540	

NOTE : For each IMD item, when two bound values before taking absolute have different signs, the relevant IMD range shall be set such that (1) the lower bound is 0 and (2) the upper bound is the bigger value of the two after taking absolute.

Based on above table , 4th order IMD may fall into Rx frequencies of band n1.

Table 6.1.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.1.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission						
	Protected band		Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n1-n78	E-UTRA Band 1, 3, 5, 7, 8, 11, 18, 19, 20, 21, 26, 28, 34, 40, 41, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	1880	-	1895	-40	1	RB restriction
	Frequency range	1895	-	1915	-15.5	5	RB restriction
	Frequency range	1915	-	1920	+1.6	5	RB restriction
NOTE 1: To simplify Table, E-UTRA band numbers are listed for bands which are specified only for E-UTRA operation or both E-UTRA and NR operation. NR band numbers are listed for bands which are specified only for NR operation.							

6.1.2.2 REFSENS requirements

Table 6.1.2.2-1 lists the MSD required due to 4th IMD for the dual uplink configuration.

Table 6.1.2.2-1: MSD due to IMD issue

Operating band / Channel bandwidth / N _{RB} / Duplex mode								Source of IMD
CA Configuration	Operating band	UL F _c (MHz)	UL/DL BW (MHz)	UL L _{CRB}	DL F _c (MHz)	MSD (dB)	Duplex mode	
CA_n1A-n78A CA_n1A-n78(2A)	n1	1950	5	25	2140	8.0	FDD	IMD4
	n78	3710	10	50	3710	10.7 ²		
NOTE 1: RB _{START} = 0 NOTE 2: Applicable only if operation with 4 antenna ports is supported in the band with carrier aggregation configured. NOTE 3: 15 kHz SCS is assumed.								

6.2 CA_n3-n79

6.2.1 Common for 1 band UL and 2 bands UL CA

6.2.1.1 Operating bands for CA

Table 6.2.1.1-1: CA band combination of band n3+n79

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode		
	BS receive / UE transmit		BS transmit / UE receive				
	$F_{UL_low} - F_{UL_high}$		$F_{DL_low} - F_{DL_high}$				
n3	1710 MHz	–	1785 MHz	1805 MHz	–	1880 MHz	FDD
n79	4400 MHz	–	5000 MHz	4400 MHz	–	5000 MHz	TDD

6.2.1.2 Channel bandwidths per operating band for CA

Table 6.2.2-1: Supported bandwidths per CA band combination of band n3+n79

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n3A-n79A	CA_n3A-n79A	n3	15	Yes	Yes	Yes	Yes	Yes	Yes							0
			30		Yes	Yes	Yes	Yes	Yes							
			60		Yes	Yes	Yes	Yes	Yes							
		n79	15							Yes	Yes					
			30							Yes	Yes	Yes	Yes		Yes	
			60							Yes	Yes	Yes	Yes		Yes	

6.2.1.3 Co-existence studies

The studies for 1 band UL for the CA band combination of band n3 + n79 have been already completed and captured into TR 37.865-01-01. There are no harmonic issues for 1 band UL according to TR 37.865-01-01.

6.2.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n3-n79, the $T_{IB,c}$ and $R_{IB,c}$ values are already specified in TR37.865-01-01.

6.2.1.5 REFSENS requirements

The studies for 1 band UL for the CA band combination of band n3 + n79 have been already completed and captured into TR 37.865-01-01. There are no need for additional REFSENS requirements for 1 band UL according to TR 37.865-01-01.

6.2.2 Specific for 2 bands UL CA

6.2.2.1 UE co-existence studies

Table 6.2.2.1-1 lists Band n3 +Band n79 2UL CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.2.2.1-1: Band n3 and Band n79 UL IMD products

6.2.2.2 REFSENS requirements

According to the co-existent analysis in table 6.2.2.1-1, although 3rd order IMD frequency range from “fx_low – max BW fy” to “fx_low + max BW fy” may fall into own Rx of band n3, MSD caused by this IM3 should not be specified due to lower PSD of NR transmission. Thus no IMD issues are expected for this CA configuration with dual uplink carrier.

6.3 CA_n66-n70

6.3.1 Common for 1 band UL and 2 bands UL CA

6.3.1.1 Operating bands for CA

Table 6.3.1.1-1: CA band combination of band n66+n70

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
	BS receive / UE transmit		BS transmit / UE receive					
	$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$				
n66	1710 – 1780			2110 – 2200			FDD	
n70	1695 – 1710			1995 – 2020			FDD	

6.3.1.2 Channel bandwidths per operating band for CA

Table 6.3.1.2-1: Supported bandwidths per CA band combination of band n66+n70

CA operating / channel bandwidth [MHz]															Bandwidth combination set	
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	
CA_n66A-n70A	-	n66	15	Yes	Yes	Yes	Yes			Yes						0
			30		Yes	Yes	Yes			Yes						
			60		Yes	Yes	Yes			Yes						
		n70	15	Yes	Yes	Yes	Yes	Yes								
			30		Yes	Yes	Yes	Yes								
			60		Yes	Yes	Yes	Yes								
CA_n66B-n70A	-	n66	See CA_n66B Bandwidth Combination Set 0 in Table 5.5A.1-1 in TS38.101-1												0	
		n70	15	Yes	Yes	Yes	Yes	Yes ₁	Yes ₁							
			30		Yes	Yes	Yes	Yes ₁	Yes ₁							
			60		Yes	Yes	Yes	Yes ₁	Yes ₁							
		n66	See CA_n66(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1 in TS38.101-1												0	
CA_n66(2A)-n70A	-	n70	15	Yes	Yes	Yes	Yes	Yes ₁	Yes ₁							
			30		Yes	Yes	Yes	Yes ₁	Yes ₁							
			60		Yes	Yes	Yes	Yes ₁	Yes ₁							

NOTE 1 This UE channel bandwidth is applicable only to downlink

6.3.1.3 UE co-existence studies

Table 6.3.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n66-n71.

Table 6.3.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		nth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n66	1710	1780	2110	2200	3420	3560	5130	5340		
n70	1695	1710	1995	2020	3390	3420	5085	5130		

Based on the table above, there is no harmonic relation.

Table 6.3.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic			3rd Harmonic		mth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	
n66	1710	1780	2110	2200	4220	4400	6330	6600			
n70	1695	1710	1995	2020	3990	4040	5985	6060			

Based on the table above, there is no harmonic mixing relation.

6.3.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n66-n70, the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 6.3.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n66-n70	n66	0.5
	n70	0.5

Table 6.1.x.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n66-n70	n66	0
	n70	0

6.3.1.5 REFSENS requirements

There are no specific REFSENS requirements for 1 band UL

6.4 CA_n66-n71

6.4.1 Common for 1 band UL and 2 bands UL CA

6.4.1.1 Operating bands for CA

Table 6.4.1.1-1: CA band combination of band n66+n71

NR Band	Uplink (UL) band				Downlink (DL) band				Duplex mode					
	BS receive / UE transmit			BS transmit / UE receive										
	$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$										
n66	1710 – 1780				2110 – 2200				FDD					
n71	663 – 698				617 – 652				FDD					

6.4.1.2 Channel bandwidths per operating band for CA

Table 6.4.1.2-1: Supported bandwidths per CA band combination of band n66+n71

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n66A-n71A	CA_n66A-n71A	n66	15	Yes	Yes	Yes	Yes			Yes						0
			30		Yes	Yes	Yes			Yes						
			60		Yes	Yes	Yes			Yes						
	n71	n71	15	Yes	Yes	Yes	Yes									
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
CA_n66(2A)-n71A	CA_n66A-n71A	n66	See CA_n66(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1 in TS38.101-1													0
			15	Yes	Yes	Yes	Yes									
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
	n71	n71	See CA_n66B Bandwidth Combination Set 0 in Table 5.5A.1-1 in TS38.101-1													0
CA_n66B-n71A	CA_n66A-n71A	n66	15	Yes	Yes	Yes	Yes									
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
			15													

6.4.1.3 UE co-existence studies

Table 6.4.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n66-n71.

Table 6.4.1.3-1: Impact of UL/DL Harmonic

						2nd Harmonic		3rd Harmonic		nth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	
n66	1710	1780	2110	2200	3420	3560	5130	5340			
n71	663	698	617	652	1326	1396	1989	2094			

Based on the table above, there is no harmonic relation.

Table 6.4.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic		3rd Harmonic		mth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n66	1710	1780	2110	2200	4220	4400	6330	6600		
n71	663	698	617	652	1234	1304	1851	1956		

Based on the table above, there is no harmonic mixing relation.

6.4.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n66-n71, the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 6.4.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n66-n71	n66	0.3
	n71	0.3

Table 6.1.x.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n66-n71	n66	0
	n71	0

6.4.1.5 REFSENS requirements

There are no specific REFSENS requirements for 1 band UL.

6.4.2 Specific for 2 bands UL CA

6.4.2.1 UE co-existence studies

Table 6.4.2.1-1: Impact of Intermodulations

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	1710	1780	663	698
Two tone 2 nd order IMD products	fy_low – fx_high	fy_high – fx_low	fx_low + fy_low	fx_high + fy_high
IMD frequency limits (MHz)	1117	1012	2373	2478
Two-tone 3 rd order IMD products	2*fx_low – fy_high	2*fx_high – fy_low	2*fy_low – fx_high	2*fy_high – fx_low
IMD frequency limits (MHz)	2722	2897	454	314
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	4083	4258	3036	3176
Two-tone 4 th order IMD products	3*fx_low – fy_high	3*fx_high – fy_low	3*fy_low – fx_high	3*fy_high – fx_low
IMD frequency limits (MHz)	4432	4677	209	384
Two-tone 4 th order IMD products	3*fx_low + fy_low	3*fx_high + fy_high	3*fy_low + fx_low	3*fy_high + fx_high
IMD frequency limits	5793	6038	3036	3874

(MHz)				
Two-tone 4 th order IMD products	$2*fy_{low} - 2*fx_{high}$	$2*fy_{high} - 2*fx_{low}$	$2*fx_{low} + 2*fy_{low}$	$2*fx_{high} + 2*fy_{high}$
IMD frequency limits (MHz)	2234	2024	4746	4956
Two-tone 5 th order IMD products	$ 4*fx_{low} - fy_{high} $	$ 4*fx_{high} - fy_{low} $	$4*fy_{low} - fx_{high}$	$4*fy_{high} - fx_{low}$
IMD frequency limits (MHz)	6142	6457	872	1082
Two-tone 5 th order IMD products	$4*fx_{low} + fy_{low}$	$4*fx_{high} + fy_{high}$	$4*fy_{low} + fx_{low}$	$4*fy_{high} + fx_{high}$
IMD frequency limits (MHz)	7503	7818	4362	4572
Two-tone 5 th order IMD products	$ 3*fx_{low} - 2*fy_{high} $	$ 3*fx_{high} - 2*fy_{low} $	$3*fy_{low} - 2*fx_{high}$	$3*fy_{high} - 2*fx_{low}$
IMD frequency limits (MHz)	3734	4014	1571	1326
Two-tone 5 th order IMD products	$2*fx_{low} + 3*fy_{low}$	$2*fx_{high} + 3*fy_{high}$	$2*fy_{low} + 3*fx_{low}$	$2*fy_{high} + 3*fx_{high}$
IMD frequency limits (MHz)	5409	5654	6456	6736

Based on the table above, there is IMD4 falling on top of n66 DL. There is pretty similar combination in EN-DC, DC_66A_n71A where MSD is defined for B66. Because the IMD mechanisms and frequencies are exactly the same, we propose to reuse that MSD number for n66.

Table 6.4.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.4.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA combination	Spurious emission					
	Protected Band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n66-n71	E-UTRA Band 4, 5, 7, 10, 12, 13, 14, 17, 26, 27, 30, 43, 50, 51, 53, 66, 70, 71, 74, 85	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 2, 25, 41, 42, 48	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 29	F_{DL_low}	-	F_{DL_high}	-38	1
	E-UTRA Band 71	F_{DL_low}	-	F_{DL_high}	-50	1
<p>NOTE 1: F_{DL_low} and F_{DL_high} refer to each frequency band specified in Table 5.2-1 in TS 38.101-1 or Table 5.5-1 in TS 36.101</p> <p>NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2 \text{ MHz} + N \times L_{CRB} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.</p> <p>NOTE 4: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.</p>						

6.4.2.2 REFSENS requirements

MSD is defined for n66 as follows.

Table 6.4.2.2-1: 2DL/2UL interband Reference sensitivity QPSK PREFSENS and uplink/downlink configurations

NR CA Configuration	NR band	UL F_c (MHz)	UL/DL BW (MHz)	UL C_{LRB}	DL F_c (MHz)	MSD (dB)	Duplex mode	Source of IMD
CA_n66A-n71A	n66	1750	5	25	2150	5	FDD	IMD4
	n71	675	5	25	629	N/A	FDD	N/A

6.5 CA_n1-n77

6.5.1 Common for 1 band UL and 2 bands UL CA

6.5.1.1 Operating bands for CA

Table 6.5.1.1-1: CA band combination of band n1+n77

NR CA Band	NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
		BS receive / UE transmit		BS transmit / UE receive			
		F_{UL_low} – F_{UL_high}	F_{DL_low} – F_{DL_high}	F_{DL_low} – F_{DL_high}	F_{DL_low} – F_{DL_high}		
CA_n1-n77	n1	1920 MHz – 1980 MHz	2110 MHz – 2170 MHz	2110 MHz – 2170 MHz	2110 MHz – 2170 MHz	FDD	
	n77	3300 MHz – 4200 MHz	TDD				

6.5.1.2 Channel bandwidths per operating band for CA

Table 6.5.1.2-1: Supported NR bandwidths per CA configuration of band n1+n77

CA operating / channel bandwidth															
NR CA Configuration	Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Maximum aggregated bandwidth [MHz]
CA_n1A-n77A	n1	15	Yes	Yes	Yes	Yes									120
		30		Yes	Yes	Yes									
		60		Yes	Yes	Yes									
	n77	15		Yes	Yes	Yes			Yes	Yes					
		30		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
		60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	

6.5.1.3 UE co-existence studies

Table 6.5.1.3-1 gives the UL 2nd, 3rd, 4th, 5th, 6th, 7th harmonics for CA_n1A-n77A.

Table 6.5.1.3-1: Band n1 and Band n77 UL harmonics products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1920	1980	3300	4200
2 nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3840	3960	6600	8400
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5760	5940	9900	12600
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	7680	7920	13200	16800
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	9600	9900	16500	21000
6th harmonics frequency limits	6*fx_low	6*fx_high	6* fy_low	6* fy_high
6th harmonics frequency limits (MHz)	11520	11880	19800	25200
7th harmonics frequency limits	7*fx_low	7*fx_high	7* fy_low	7* fy_high
7th harmonics frequency limits (MHz)	13440	13860	23100	29400

It can be seen that the 2nd harmonic interference from Band n1 UL will fall into Band n77 DL frequency range. HTF or other RF architecture should be considered to mitigate the impact of the self-interference for this combination.

6.5.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n1-n77, the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 6.5.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n1-n77	n1	0.6
	n77	0.8

Table 6.5.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n1-n77	n1	0.2
	n77	0.5

6.5.1.5 REFSENS requirements

For single uplink operation of this combination, only harmonic issue need to be considered. MSD values for Band n77 due to 2nd harmonic of Band n1 in CA_n1A-n77A are captured in Table 6.5.1.5-1.

Table 6.5.1.5-1: MSD due to harmonic issue for CA_n1-n77

		MSD due to harmonic exception for the DL band												
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	
		dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
n1	n77 ^{1,2}		23.9	22.1	20.9			17.9	16.8	16.0	14.8	14.3	13.8	
	n77 ³		1.1	0.8	0.3			0	0	0	0	0	0	

NOTE 1: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (lower) band for which the 2nd transmitter harmonic is within the downlink transmission bandwidth of a victim (higher) band.

NOTE 2: The requirements should be verified for UL EARFCN of the aggressor (lower) band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.2 \rfloor + 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{HB} carrier frequency in the victim (higher) band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the lower band.

NOTE 3: The requirements are only applicable to channel bandwidths with a carrier frequency at $\pm (20 + BW_{Channel}^{HB} / 2)$ MHz offset from $2f_{UL}^{LB}$ in the victim (higher band) with $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$, where $BW_{Channel}^{LB}$ and $BW_{Channel}^{HB}$ are the channel bandwidths configured in the aggressor (lower) and victim (higher) bands in MHz, respectively.

Table 6.5.1.5-2 Uplink configuration for the low band

NR Band / Channel bandwidth of the high band														
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n1	n77		25	36	50				100	100	100	100	100	100

6.6 CA_n1-n79

6.6.1 Common for 1 band UL and 2 bands UL CA

6.6.1.1 Operating bands for CA

Table 6.6.1.1-1: CA band combination of band n1+n79

NR Band	Uplink (UL) band				Downlink (DL) band				Duplex mode					
	BS receive / UE transmit		BS transmit / UE receive											
	$F_{UL_low} - F_{UL_high}$		$F_{DL_low} - F_{DL_high}$											
n1	1920 MHz – 1980 MHz		2110 MHz – 2170 MHz						FDD					
n79	4400 MHz – 5000 MHz		4400 MHz – 5000 MHz						TDD					

6.6.1.2 Channel bandwidths per operating band for CA

Table 6.6.1.2-1: Supported bandwidths per CA band combination of band n1+n79

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS kHz	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n1A-n79A	CA_n1A-n79A	n1	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
		n79	15							Yes	Yes					
			30							Yes	Yes	Yes	Yes		Yes	
			60							Yes	Yes	Yes	Yes	Yes	Yes	

6.6.1.3 Co-existence studies

Table 6.6.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n1-n79.

Table 6.6.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		nth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n1	1920	1980	2110	2170	3840	3960	5760	5940		
n79	4400	5000	4400	5000	8800	10000	13200	15000		

Based on above table, there is no harmonic issue for the band combination of n1 and n79.

Table 6.6.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic		3rd Harmonic		mth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n1	1920	1980	2110	2170	4220	4340	6330	6510		
n79	4400	5000	4400	5000	8800	10000	13200	15000		

Based on above table, there is no harmonic mixing issue for the band combination of n1 and n79.

6.6.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n1-n79, the $T_{IB,c}$ and R_{IB} values are given in the tables below.

Table 6.6.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n1-n79	n1	0
	n79	0

Table 6.6.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	ΔR_{IB} [dB]
CA_n1-n79	n1	0
	n79	0

6.6.1.5 REFSENS requirements

According to the co-existence studies in section 6.6.1.3, there are no harmonic issues in this combination. Thus there are no change in Band n1 or Band n79 REFSENS requirements are needed

6.6.2 Specific for 2 bands UL CA

6.6.2.1 UE co-existence studies

Table 6.6.2.1-1 lists Band n1 + Band n79 2UL CA 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.6.2.1-1: Band n1 and Band n79 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency	1920	1980	4400	5000
2 nd order IMD products	fy_low-fx_high	fy_high-fx_low	fy_low+fx_low	fy_high+fx_high
IMD frequency limits (MHz)	2420 - 3080		6320 - 6980	
Two-tone 3 rd order IMD products	2*fx_low - fy_high	2*fx_high - fy_low	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	440 - 1160		6820 - 8080	
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	8240 - 8960		10720 - 11980	
Two-tone 3 rd order IMD products	(fx_low - max BW fy)	(fx_high + max BW fy)	(fy_low - max BW fx)	(fy_high + max BW fx)
IMD frequency limits (MHz)	1820 - 2080		4380 - 5020	
Two-tone 4th order IMD products	2*fx_low - 2* fy_high	2*fx_high - 2*fy_low		
IMD frequency limits (MHz)	4840 - 6160			
Two-tone 4th order IMD products	3*fx_low - 1* fy_high	3*fx_high - 1*fy_low	3*fy_low - 1*fx_high	3*fy_high - 1*fx_low
IMD frequency limits (MHz)	760 - 1540		11220 - 13080	
Two-tone 4th order IMD products	2*fx_low + 2* fy_low	2*fx_high + 2* fy_high		
IMD frequency limits (MHz)	12640 - 13960			
Two-tone 4th order IMD products	3*fx_low + 1* fy_low	3*fx_high + 1* fy_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high
IMD frequency limits (MHz)	10160 - 10940		15120 - 16980	
Two-tone 5th order IMD products	fx_low - 4*fy_high	fx_high - 4*fy_low	fy_low - 4*fx_high	fy_high - 4*fx_low
IMD frequency limits (MHz)	15620 - 18080		2680 - 3520	
Two-tone 5th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
IMD frequency limits (MHz)	19520 - 21980		12080 - 12920	
Two-tone 5th order IMD products	2*fx_low - 3*fy_high	2*fx_high - 3*fy_low	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)	9240 - 11160		2860 - 4240	
Two-tone 5th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	17040 - 18960		14560 - 15940	

NOTE : For each IMD item, when two bound values before taking absolute have different signs, the relevant IMD range shall be set such that (1) the lower bound is 0 and (2) the upper bound is the bigger value of the two after taking absolute.

Based on Table 6.6.2.1-1:

- There are no IMD will fall into own Rx of band n1.
- 3rd and 4th order IMD may fall into own Rx of band n79. Since band n79 is TDD band, it is no need to consider the IMD issue for band n79 which means no self-interference for the TDD band n79

Table 6.6.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.6.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n1A-n79A	E-UTRA Band 1, 3, 5, 7, 8, 11, 18, 19, 21, 26, 28, 34, 40, 41, 42, 65	F _{DL_low}	-	F _{DL_high}	-50	1	
	Frequency range	1880	-	1895	-40	1	RB restriction
	Frequency range	1895	-	1915	-15.5	5	RB restriction
	Frequency range	1915	-	1920	+1.6	5	RB restriction

NOTE 1: To simplify Table, E-UTRA band numbers are listed for bands which are specified only for E-UTRA operation or both E-UTRA and NR operation. NR band numbers are listed for bands which are specified only for NR operation.

6.6.2.2 REFSENS requirements

According to the co-existent analysis in table 6.6.2.1-1, there are no IMD issues are expected for this CA configuration with dual uplink carrier.

6.7 CA_n3-n41

6.7.1 Common for 1 band UL and 2 bands UL

6.7.1.1 Operating bands for CA

Table 6.7.1.1-1: CA band combination of band n3+n41

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
	BS receive / UE transmit		BS transmit / UE receive			
	F _{UL_low} – F _{UL_high}	F _{DL_low} – F _{DL_high}	F _{DL_low} – F _{DL_high}	F _{DL_low} – F _{DL_high}		
n3	1710 MHz – 1785 MHz		1805 MHz – 1880 MHz		FDD	
n41	2496 MHz – 2690 MHz		2496 MHz – 2690 MHz		TDD	

6.7.1.2 Channel bandwidths per operating band for CA

Table 6.7.1.2-1: Supported bandwidths per CA band combination of band n3+n41

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS kHz	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n3A-n41A	CA_n3A-n41A	n3	15	Yes	Yes	Yes	Yes	Yes	Yes							0
			30		Yes	Yes	Yes	Yes	Yes							
			60		Yes	Yes	Yes	Yes	Yes							
		n41	15		Yes	Yes	Yes			Yes	Yes					0
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
		n3	15	Yes	Yes	Yes	Yes	Yes	Yes							1
			30		Yes	Yes	Yes	Yes	Yes							
			60		Yes	Yes	Yes	Yes	Yes							
		n41	15		Yes	Yes	Yes			Yes	Yes					1
			30		Yes	Yes	Yes			Yes	Yes	Yes				
			60		Yes	Yes	Yes			Yes	Yes	Yes				

6.7.1.3 UE co-existence studies

Table 6.7.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n3-n41.

Table 6.7.1.3-1: Impact of UL/DL Harmonic

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2nd Harmonic		3rd Harmonic		nth Harmonic	
					UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n3	1710	1785	1805	1880	3420	3570	5130	5355		
n41	2496	2690	2496	2690	4992	5380	7488	8070		

Based on above table, there is no harmonic issue for the band combination of n3 and n41.

Table 6.7.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic		3rd Harmonic		mth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n3	1710	1785	1805	1880	3610	3760	5415	5640		
n41	2496	2690	2496	2690	4992	5380	7488	8070		

Based on above table, there is no harmonic mixing issue for the band combination of n3 and n41.

6.7.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n3-n41, the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 6.7.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n3-n41	n3	0.5
	n41	0.3 ¹
		0.8 ²

NOTE 1: The requirement is applied for UE transmitting on the frequency range of 2515-2690 MHz.
 NOTE 2: The requirement is applied for UE transmitting on the frequency range of 2496-2515 MHz.

Table 6.7.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n3-n41	n3	0
	n41	0 ¹
		0.5 ²

NOTE 1: The requirement is applied for UE transmitting on the frequency range of 2515-2690 MHz.
 NOTE 2: The requirement is applied for UE transmitting on the frequency range of 2496-2515 MHz.

6.7.1.5 REFSENS requirements

For this combinations, sensitivity degradation is allowed for a band if it is impacted by UL of another band part of the same DC configuration due to cross band isolation issues. Reference sensitivity exceptions are specified in Table 6.7.1.5-1 with uplink configuration specified in Table 6.7.1.5-2.

Table 6.7.1.5-1: MSD due to cross band isolation

NR CA Configuration	NR UL band	NR DL band	Channel bandwidth											
			5 MHz (dBm)	10 MHz (dBm)	15 MHz (dBm)	20 MHz (dBm)	25 MHz (dBm)	30 MHz (dBm)	40 MHz (dBm)	50 MHz (dBm)	60 MHz (dBm)	80 MHz (dBm)	90 MHz (dBm)	100 MHz (dBm)
CA_n3A-n41A	n3	n41		[4.3]	[4.0]	[3.9]			[3.5]	[3.3]	[3.2]	[3.1]	[3.0]	[3.0]
	n41	n3	[3.0]	[3.0]	[3.0]	[3.1]	[3.0]	[3.0]						

NOTE 1: The Band n41 requirements are modified by -0.5dB when carrier frequency of the assigned NR channel bandwidth is within 2515-2690 MHz.

Table 6.7.1.5-2: Uplink configuration for reference sensitivity exceptions due to cross band isolation

Channel bandwidth of the affected DL band														
NR UL band	NR DL band	SCS of UL band (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n3	n41	15		50	50 ¹	50 ¹			50 ¹					
		30		24	24 ¹	24 ¹			24 ¹					
n41	3	15	25	50	75	100	128	160						
		30	10	24	36	50	64	75						
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 bandwidth configuration for the channel bandwidth (Table 5.3.2-1 in TS38.101-1).														

6.7.2 Specific for 2 bands UL CA

6.7.2.1 UE co-existence studies

Table 6.7.2.1-1 lists Band n3 +Band n41 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.7.2.1-1: Band n3 and Band n41 2 UL bands IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	1710	1785	2496	2690
2 nd order IMD products	fy_low - fx_high	fy_high - fx_low	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	711 – 980		4206 – 4475	
Two-tone 3 rd order IMD products	2*fx_low - fy_high	2*fx_high - fy_low	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	730 – 1074		3207 – 3670	
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	5916 – 6260		6702 – 7165	
Two-tone 3 rd order IMD products	(fx_low – max BW fy)	(fx_high + max BW fy)	(fy_low – max BW fx)	(fy_high + max BW fx)
IMD frequency limits (MHz)	1610 – 1885		2466 – 2720	
Two-tone 4 th order IMD products	3*fx_low - 1*fy_high	3*fx_high - 1*fy_low	3*fy_low - 1*fx_high	3*fy_high - 1*fx_low
IMD frequency limits (MHz)	2440 – 2859		5703 – 6360	
Two-tone 4 th order IMD products	2*fx_low - 2*fy_high	2*fx_high - 2*fy_low		
IMD frequency limits (MHz)	1422 – 1960			
Two-tone 4 th order IMD products	3*fx_low + 1*fy_low	3*fx_high + 1*fy_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high
IMD frequency limits (MHz)	7626 – 8045		9198 – 9855	
Two-tone 4 th order IMD products	2*fx_low + 2*fy_low	2*fx_high + 2*fy_high		
IMD frequency limits (MHz)	8412 – 8950			
Two-tone 5 th order IMD products	fx_low - 4*fy_high	fx_high - 4*fy_low	fy_low - 4*fx_high	fy_high - 4*fx_low
IMD frequency limits (MHz)	8199 – 9050		4150 – 4644	
Two-tone 5 th order IMD products	2*fx_low - 3*fy_high	2*fx_high - 3*fy_low	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)	3918 – 4650		0 – 363	
Two-tone 5 th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
IMD frequency limits (MHz)	11694 – 12545		9336 – 9830	
Two-tone 5 th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	10908 – 11640		10122 – 10735	
NOTE : For each IMD item, when two bound values before taking absolute have different signs, the relevant IMD range shall be set such that (1) the lower bound is 0 and (2) the upper bound is the bigger value of the two after taking absolute.				

Based on above table, 4th order IMD may fall into Rx frequencies of band n3 and n41. But these IMDs do not affect n41 Rx since n41 is TDD band.

Table 6.7.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.7.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n3A-n41A	E-UTRA Band 1, 5, 8, 20, 26, 27, 28, 34, 39, 40, 44, 45, 50, 51, 65, 73, 74	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 3	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 11, 18, 19, 21	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 42, NR Band n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3
<p>NOTE 1: To simplify Table, E-UTRA band numbers are listed for bands which are specified only for E-UTRA operation or both E-UTRA and NR operation. NR band numbers are listed for bands which are specified only for NR operation.</p> <p>NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2\text{MHz} + N \times \text{LCRB} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.</p> <p>NOTE 3: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 and Table 6.5A.3.1-1 from the edge of the channel bandwidth.</p> <p>NOTE 4: This requirement applies for 5, 10, 15 and 20 MHz NR channel bandwidth allocated within 1744.9MHz and 1784.9MHz.</p> <p>NOTE 5: This requirement applies when the NR carrier is confined within 2545-2575MHz or 2595-2645MHz and the channel bandwidth is 10 or 20 MHz</p> <p>NOTE 6: Applicable when co-existence with PHS system operating in 1884.5 - 1915.7 MHz.</p>						

6.7.2.2 REFSENS requirements

Table 6.7.2.2-1 lists the MSD required due to 4th IMD for the dual uplink configuration.

Table 6.7.2.2-1: MSD due to IMD issue

Operating band / Channel bandwidth / N_{RB} / Duplex mode								Source of IMD
CA Configuration	Operating band	UL F_c (MHz)	UL/DL BW (MHz)	UL C_{LRB}	DL F_c (MHz)	MSD (dB)	Duplex mode	
CA_n3A-n41A	n3	1740	5	25	1835	8.2	FDD	IMD4
	n41	2657.5	10	50	2657.5	N/A	TDD	N/A
NOTE 1: $RB_{START} = 0$ NOTE 2: 15 kHz SCS is assumed.								

6.8 CA_n39-n41

6.8.1 Common for 1 band UL and 2 bands UL

6.8.1.1 Operating bands for CA

Table 6.8.1.1-1: CA band combination of band n39+n41

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
	BS receive / UE transmit			BS transmit / UE receive				
	$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$				
n39	1880 MHz	–	1920 MHz	1880 MHz	–	1920 MHz	TDD	
n41	2496 MHz	–	2690 MHz	2496 MHz	–	2690 MHz	TDD	

6.8.1.2 Channel bandwidths per operating band for CA

Table 6.8.1.2-1: Supported bandwidths per CA band combination of band n39+n41

CA operating / channel bandwidth [MHz]																0
NR CA Configuration	UL Configuration	NR Band	SCS kHz	5	10	15	20	25	30	40	50	60	80	90	100	
CA_n39A-n41A	CA_n39A-n41A	n39	15	Yes												
			30	Yes												
			60	Yes												
	n41	n41	15	Yes	Yes	Yes				Yes	Yes					
			30	Yes	Yes	Yes				Yes	Yes	Yes	Yes	Yes	Yes	
			60	Yes	Yes	Yes				Yes	Yes	Yes	Yes	Yes	Yes	

6.8.1.3 UE co-existence studies

Table 6.8.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n39-n41.

Table 6.8.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		nth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n39	1880	1920	1880	1920	3760	3840	5640	5760		
n41	2496	2690	2496	2690	4992	5380	7488	8070		

Based on above table, there is no harmonic issue for the band combination of n39 and n41.

Table 6.8.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic			3rd Harmonic		mth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	
n39	1880	1920	1880	1920	3760	3840	5640	5760			
n41	2496	2690	2496	2690	4992	5380	7488	8070			

Based on above table, there is no harmonic mixing issue for the band combination of n39 and n41.

6.8.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n39-n41, the $T_{IB,c}$ and $R_{IB,c}$ values for UEs not supporting simultaneous Rx/Tx are given in the tables below.

Table 6.8.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]	
CA_n39-n41	n39	0 ¹	
		0.5 ²	
	n41	0 ¹	
		0.5 ²	
NOTE 1: Only applicable for UE supporting inter-band carrier aggregation with uplink in one NR band and without simultaneous Rx/Tx.			
NOTE 2: Applicable for UE supporting inter-band carrier aggregation without simultaneous Rx/Tx.			

Table 6.8.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]	
CA_n39-n41	n39	0.2 ¹	
		0.2 ²	
	n41	0.2 ¹	
		0.2 ²	
NOTE 1: Only applicable for UE supporting inter-band carrier aggregation with uplink in one NR band and without simultaneous Rx/Tx.			
NOTE 2: Applicable for UE supporting inter-band carrier aggregation without simultaneous Rx/Tx.			

6.8.1.5 REFSENS requirements

Since the focus of this combination is not supporting simultaneous Tx/Rx, there are no specific REFSENS requirements for 1 band UL

6.8.2 Specific for 2 bands UL CA

6.8.2.1 UE co-existence studies

Table 6.8.2.1-1 lists Band n39 +Band n41 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.8.2.1-1: Band n39 and Band n41 2UL bands IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	1880	1920	2496	2690
2 nd order IMD products	fy_low - fx_high	fy_high - fx_low	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	576 – 810		4376 – 4610	
Two-tone 3 rd order IMD products	2*fx_low - fy_high	2*fx_high - fy_low	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	1070 – 1344		3072 – 3500	
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	6256 – 6530		6872 – 7300	
Two-tone 3 rd order IMD products	(fx_low – max BW fy)	(fx_high + max BW fy)	(fy_low – max BW fx)	(fy_high + max BW fx)
IMD frequency limits (MHz)	1780 – 2020		2456 – 2730	
Two-tone 4 th order IMD products	3*fx_low - 1*fy_high	3*fx_high - 1*fy_low	3*fy_low - 1*fx_high	3*fy_high - 1*fx_low
IMD frequency limits (MHz)	2950 – 3264		5568 – 6190	
Two-tone 4 th order IMD products	2*fx_low - 2*fy_high	2*fx_high - 2*fy_low		
IMD frequency limits (MHz)	1152 – 1620			
Two-tone 4 th order IMD products	3*fx_low + 1*fy_low	3*fx_high + 1*fy_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high
IMD frequency limits (MHz)	8136 – 8450		9368 – 9990	
Two-tone 4 th order IMD products	2*fx_low + 2*fy_low	2*fx_high + 2*fy_high		
IMD frequency limits (MHz)	8752 – 9220			
Two-tone 5 th order IMD products	fx_low - 4*fy_high	fx_high - 4*fy_low	fy_low - 4*fx_high	fy_high - 4*fx_low
IMD frequency limits (MHz)	8064 – 8880		4830 – 5184	
Two-tone 5 th order IMD products	2*fx_low - 3*fy_high	2*fx_high - 3*fy_low	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)	3648 – 4310		260 – 768	
Two-tone 5 th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
IMD frequency limits (MHz)	11864 – 12680		10016 – 10370	
Two-tone 5 th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	11910 – 11248		10632 – 11140	

NOTE : For each IMD item, when two bound values before taking absolute have different signs, the relevant IMD range shall be set such that (1) the lower bound is 0 and (2) the upper bound is the bigger value of the two after taking absolute.

As IMD is not an issue for TDD bands combination, there is no MSD issue for this band combination.

Table 6.8.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.8.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n39A-n41A	E-UTRA Band 1, 8, 26, 34, 40, 42, 44, 45, 50, 51, 74	F_{DL_low}	-	F_{DL_high}	-50	1
	NR Band n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1
	Frequency range	1805	-	1855	-40	1
	Frequency range	1855	-	1880	-15.5	5
NOTE 1: To simplify Table, E-UTRA band numbers are listed for bands which are specified only for E-UTRA operation or both E-UTRA and NR operation. NR band numbers are listed for bands which are specified only for NR operation.						3, 4, 5
NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2\text{MHz} + N \times \text{LCRB} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.						
NOTE 3: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 and Table 6.5A.3.1-1 from the edge of the channel bandwidth.						
NOTE 4: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.						
NOTE 5: This requirement is only applicable for carriers with bandwidth confined within 1885-1920 MHz (requirement for carriers with at least 1RB confined within 1880 - 1885 MHz is not specified). This requirement applies for an uplink transmission bandwidth less than or equal to 54 RB for carriers of 15 MHz bandwidth when carrier center frequency is within the range 1892.5 - 1894.5 MHz and for carriers of 20 MHz bandwidth when carrier center frequency is within the range 1895 - 1903 MHz.						

NOTE: All the tables mentioned in the note of above table are specified in TS38.101-1.

6.8.2.2 REFSENS requirements

As IMD is not an issue for TDD bands combination, there is no MSD issue for this combination.

6.9 CA_n8-n41

6.9.1 Common for 1 band UL and 2 bands UL

6.9.1.1 Operating bands for CA

Table 6.9.1.1-1: CA band combination of band n8+n41

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
	BS receive / UE transmit		BS transmit / UE receive			
	F_{UL_low} – F_{UL_high}	F_{DL_low} – F_{DL_high}	F_{DL_low} – F_{DL_high}	F_{DL_low} – F_{DL_high}		
n8	880 MHz – 915 MHz	925 MHz – 960 MHz	925 MHz – 960 MHz	925 MHz – 960 MHz	FDD	
n41	2496 MHz – 2690 MHz	TDD				

6.9.1.2 Channel bandwidths per operating band for CA

Table 6.9.1.2-1: Supported bandwidths per CA band combination of band n8+n41

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n8A-n41A	CA_n8A-n41A	n8	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60													
		n41	15		Yes	Yes	Yes			Yes	Yes					1
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
		n8	15	Yes	Yes	Yes	Yes									1
			30		Yes	Yes	Yes									
			60													
		n41	15		Yes	Yes	Yes			Yes	Yes					1
			30		Yes	Yes	Yes			Yes	Yes					
			60		Yes	Yes	Yes			Yes	Yes					

6.9.1.3 UE co-existence studies

Table 6.9.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n8-n41.

Table 6.9.1.3-1: Impact of UL/DL Harmonic

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2nd Harmonic		3rd Harmonic		4th Harmonic	
					UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n8	880	915	925	960	1760	1830	2640	2745	3520	3660
n41	2496	2690	2496	2690	4992	5380	7488	8070	9984	10760

Based on above table, the 3rd order harmonic of Band n8 will fall into Band n41.

Table 6.9.1.3-2: Impact of UL/DL Harmonic mixing

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2nd Harmonic		3rd Harmonic		m th Harmonic	
					DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n8	880	915	925	960	1850	1920	2775	2880		
n41	2496	2690	2496	2690	4992	5380	7488	8070		

Based on above table, there is no harmonic mixing issue for the band combination of n8 and n41.

6.9.1.4 ΔT_{IB} and $\Delta R_{IB,c}$ values

For CA_n8-n41 , the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 6.9.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n8-n41	n8	0.6
	n41	0.3

Table 6.9.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,C}$ [dB]
CA_n8-n41	n8	0
	n41	0

6.9.1.5 REFSENS requirements

MSD needs to be considered for Band n41 due to 3rd harmonic interference from Band n8. A diplexer is adopted to combine the two bands, i.e. diplexer + duplexer architecture is used to estimate the MSD due to 3rd harmonic.

The reference sensitivity exceptions for CA_n8-n41 are proposed in Table 6.9.1.5-1 with the uplink configurations specified in Table 6.9.1.5-2.

Table 6.9.1.5-1: MSD due to UL harmonic for CA_n8-n41

UL band	DL band	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	30 MHz (dB)	40 MHz (dBm)	50 MHz (dBm)	60 MHz (dBm)	80 MHz (dBm)	90 MHz (dBm)	100 MHz (dBm)
n8	n41 ^{8,9}	N/A	13	11.3	10.1			7.0	6.1	5.5	4.3	3.9	3.5

NOTE 1: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of a low band for which the 3rd transmitter harmonic is within the downlink transmission bandwidth of a high band.

NOTE 2: The requirements should be verified for UL EARFCN of a low band (superscript LB) such that

$$f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.3 \rfloor \text{ in MHz and } F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2 \text{ with } f_{DL}^{HB} \text{ the carrier frequency of a high band in MHz and } BW_{Channel}^{LB} \text{ the channel bandwidth configured in the low band.}$$

Table 6.9.1.5-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for CA_n8-n41

	NR Band / Channel bandwidth of the high band												
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n8	n41		16	25	25			25	25	25	25	25	25

6.9.2 Specific for 2 bands UL CA

6.9.2.1 UE co-existence studies

Table 6.9.2.1-1 gives IMD interference analysis for CA_n8-n41 with 2 ULs.

Table 6.9.2.1-1: Band n8 and Band n41 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency range	880	915	2496	2690
Two tone 2 nd order IMD products	fy_low - fx_high	fy_high - fx_low	fy_low + fx_low	fy_high + fx_high
	1581	1810	3376	3605
Two-tone 3 rd order IMD products	2*fx_low - fy_high	2*fx_high - fy_low	2*fy_low - fx_high	2*fy_high - fx_low
	930	666	4077	4500
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
	4256	4520	5872	6295
Two-tone 3 rd order IMD products	fx_low-max BW fy	fx_high+max BW fy	fy_low-max BW fx	fy_high+max BW fx
	780	1015	2476	2710
Two-tone 4 th order IMD products	3*fx_low - fy_high	3*fx_high - fy_low	3*fy_low - fx_high	3*fy_high - fx_low
	50	249	6573	7190
Two-tone 4 th order IMD products	3*fx_low + fy_low	3*fx_high + fy_high	3*fy_low + fx_low	3*fy_high + fx_high
	5136	5435	8368	8985
Two-tone 4 th order IMD products	2*fx_low - 2*fy_high	2*fx_high - 2*fy_low	2*fx_low + 2*fy_low	2*fx_high + 2*fy_high
	3620	3162	6752	7210

Two-tone 4 th order IMD products*1	fy_low – fx_high	fy_high – fx_low	fy_low + fx_low	fy_high + fx_high
	1581	1810	3376	3605
Two-tone 4 th order IMD products*1	2*fx_low	2*fx_high	2*fy_low	2*fy_high
	1760	1830	4992	5380
Two-tone 5 th order IMD products	fx_low – 4*fy_high	fx_high – 4*fy_low	fy_low – 4*fx_high	fy_high – 4*fx_low
	9880	9069	1164	830
Two-tone 5 th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
	10864	11675	6016	6350
Two-tone 5 th order IMD products	2*fx_low – 3*fy_high	2*fx_high – 3*fy_low	2*fy_low – 3*fx_high	2*fy_high – 3*fx_low
	6310	5658	2247	2740
Two-tone 5 th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
	9248	9900	7632	8125
Two-tone 5 th order IMD products*2	3*fx_low	3*fx_high	3*fy_low	3*fy_high
	2640	2745	7488	8070
Two-tone 5 th order IMD products*2	2*fx_low – fy_high	2*fx_high – fy_low	2*fy_low – fx_high	2*fy_high – fx_low
	930	666	4077	4500
Two-tone 5 th order IMD products*2	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
	4256	4520	5872	6295

NOTE1: The center frequency of this IMD is the same as that of 2nd harmonics and IMD. It is depending on the proponents of each band combination to include the impact of this IMD in MSD analysis.

NOTE2: The center frequency of this IMD is the same as that of 3rd harmonics and IMD. It is depending on the proponents of each band combination to include the impact of this IMD in MSD analysis.

Based on above table, the 3rd and 5th order IMD may fall into Rx frequencies of band n8 and the 3rd order IMD may fall into Rx frequencies of Band n41. However IMD is not an issue for Band n41 since it is a TDD band. MSD need to be considered for Band n8.

Table 6.9.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.9.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA Configuration	Spurious emission					
	Protected Band	Frequency range (Mhz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n8A-n41A	E-UTRA Band 1, 28, 34, 39, 40, 45, 50, 51, 65, 73, 74, n77, 78, 79	F _{DL_low}	-	F _{DL_high}	-50	1
	E-UTRA band 3, 42, 52	F _{DL_low}	-	F _{DL_high}	-50	1
	E-UTRA band 11, 21	F _{DL_low}	-	F _{DL_high}	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3

NOTE 1: F_{DL_low} and F_{DL_high} refer to each frequency band specified in Table 5.2-1 or Table 5.5-1 in TS 36.101

NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of (2MHz + N x LCRB x 180kHz), where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.

NOTE 3: Applicable when co-existence with PHS system operating in 1884.5 - 1915.7 MHz.

6.9.2.2 REFSENS requirements

Table 6.9.2.2-1 lists the MSD required due to 3rd order and 5th IMD for the dual uplink configuration.

Table 6.9.2.2-1: MSD due to IMD issue

Operating Band / Channel bandwidth / N _{RB} / Duplex mode								Source of IMD
EUTRA CA Configuration	EUTRA band	UL F _c (MHz)	UL/DL BW (MHz)	UL C _{LRB}	DL F _c (MHz)	MSD (dB)	Duplex mode	
CA_8A-41A	8	882.5	5	25	927.5	12.1	FDD	IMD3 ⁴
	41	2685	10	50	2685	N/A	TDD	N/A
NOTE 1: Both of the transmitters shall be set min(+20 dBm, P _{CMAX_L.c}). NOTE 2: RB _{START} = 0. NOTE 3: 15kHz SCS is assumed. NOTE 4: This band is subject to IMD5 also which MSD is not specified.								

6.10 CA_n41-n79

6.10.1 Common for 1 band UL and 2 bands UL

6.10.1.1 Operating bands for CA

Table 6.10.1.1-1: CA band combination of band n41+n79

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
	BS receive / UE transmit			BS transmit / UE receive				
	F _{UL_low} – F _{UL_high}	F _{DL_low} – F _{DL_high}						
n41	2496 MHz – 2690 MHz			2496 MHz – 2690 MHz			TDD	
n79	4400 MHz – 5000 MHz			4400 MHz – 5000 MHz			TDD	

6.10.1.2 Channel bandwidths per operating band for CA

Table 6.10.1.2-1: Supported bandwidths per CA band combination of band n41+n79

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n41A-n79A	CA_n41A-n79A	n41	15		Yes	Yes	Yes			Yes	Yes					0
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
			60							Yes	Yes	Yes	Yes	Yes	Yes	
		n79	15							Yes	Yes					1
			30							Yes	Yes	Yes	Yes			
			60							Yes	Yes	Yes	Yes			
		n41	15		Yes	Yes	Yes			Yes	Yes					1
			30		Yes	Yes	Yes			Yes	Yes	Yes				
			60		Yes	Yes	Yes			Yes	Yes	Yes				
		n79	15							Yes	Yes					1
			30							Yes	Yes	Yes	Yes			
			60							Yes	Yes	Yes	Yes			

6.10.1.3 UE co-existence studies

Table 6.10.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n41-n79.

Table 6.10.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		4th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n79	4400	5000	4400	5000	8800	10000	13200	15000	17600	20000
n41	2496	2690	2496	2690	4992	5380	7488	8070	9984	10760

Based on above table, the 2nd order harmonic of Band n41 will fall into Band n79.

Table 6.10.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic			3rd Harmonic		m th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	
n79	4400	5000	4400	5000	8800	10000	13200	15000			
n41	2496	2690	2496	2690	4992	5380	7488	8070			

Based on above table, there will be harmonic mixing issue when the assigned frequency is at the lower edge in Band n41.

However, according to the analysis in EN-DC_41-n79 in TR 36.863-01-01, there will be no harmonic and/or harmonic mixing issue as long as the frequency in Band 41 is above 2506. According to the spectrum situation in China and Japan, the lowest frequency to be used for this combination is 2515MHz. So there will be no harmonic and/or harmonic mixing issue.

A note is proposed to clarify the frequency to be used in Band 41 as “*Note: The lowest frequency is 2506 in Band 41 for this band combination.*”

6.10.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n41-n79, the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 6.10.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n41-n79	n41	0.3
	n79	0.8

Table 6.10.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n41-n79	n41	0.5
	n79	0.5

6.10.1.5 REFSENS requirements

No specific REFSENS requirements need to be specified.

6.10.2 Specific for 2 bands UL CA

6.10.2.1 UE co-existence studies

Table 6.10.2.1-1 gives IMD interference analysis for CA_n41-n79 with 2 ULs.

Table 6.10.2.1-1: Band n41 and Band n79 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency range	2496	2690	4400	5000
Two tone 2 nd order IMD products	fy_low - fx_high 1710	fy_high - fx_low 2504	fy_low + fx_low 6896	fy_high + fx_high 7690
Two-tone 3 rd order IMD products	2*fx_low - fy_high 8	2*fx_high - fy_low 980	2*fy_low - fx_high 6110	2*fy_high - fx_low 7504
Two-tone 3 rd order IMD products	2*fx_low + fy_low 9392	2*fx_high + fy_high 10380	2*fy_low + fx_low 11296	2*fy_high + fx_high 12690
Two-tone 3 rd order IMD products	fx_low-max BW fy 2396	fx_high+max BW fy 2790	fy_low-max BW fx 4300	fy_high+max BW fx 5100
Two-tone 4 th order IMD products	3*fx_low - fy_high 2488	3*fx_high - fy_low 3670	3*fy_low - fx_high 10510	3*fy_high - fx_low 12504
Two-tone 4 th order IMD products	3*fx_low + fy_low 11888	3*fx_high + fy_high 13070	3*fy_low + fx_low 15696	3*fy_high + fx_high 17690
Two-tone 4 th order IMD products	2*fx_low - 2*fy_high 5008	2*fx_high - 2*fy_low 3420	2*fx_low + 2*fy_low 13792	2*fx_high + 2*fy_high 15380
Two-tone 4 th order IMD products*1	fy_low - fx_high 1710	fy_high - fx_low 2504	fy_low + fx_low 6896	fy_high + fx_high 7690
Two-tone 4 th order IMD products*1	2*fx_low 4992	2*fx_high 5380	2*fy_low 6896	2*fy_high 7690
Two-tone 5 th order IMD products	fx_low - 4*fy_high 17504	fx_high - 4*fy_low 14910	fy_low - 4*fx_high 6360	fy_high - 4*fx_low 4984
Two-tone 5 th order IMD products	fx_low + 4*fy_low 20096	fx_high + 4*fy_high 22690	fy_low + 4*fx_low 14384	fy_high + 4*fx_high 15760
Two-tone 5 th order IMD products	2*fx_low - 3*fy_high 10008	2*fx_high - 3*fy_low 7820	2*fy_low - 3*fx_high 730	2*fy_high - 3*fx_low 2512
Two-tone 5 th order IMD products	2*fx_low + 3*fy_low 18192	2*fx_high + 3*fy_high 20380	2*fy_low + 3*fx_low 16288	2*fy_high + 3*fx_high 18070
Two-tone 5 th order IMD products*2	3*fx_low 7488	3*fx_high 8070	3*fy_low 13200	3*fy_high 15000
Two-tone 5 th order IMD products*2	2*fx_low - fy_high 8	2*fx_high - fy_low 980	2*fy_low - fx_high 6110	2*fy_high - fx_low 7504
Two-tone 5 th order IMD products*2	2*fx_low + fy_low 9392	2*fx_high + fy_high 10380	2*fy_low + fx_low 11296	2*fy_high + fx_high 12690

NOTE1: The center frequency of this IMD is the same as that of 2nd harmonics and IMD. It is depending on the proponents of each band combination to include the impact of this IMD in MSD analysis.

NOTE2: The center frequency of this IMD is the same as that of 3rd harmonics and IMD. It is depending on the proponents of each band combination to include the impact of this IMD in MSD analysis.

IMD is not an issue for this band combination as the involved bands are all TDD bands. The above IMD interference analysis is just for information.

Table 6.10.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.10.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA Configuration	Spurious emission						
	Protected Band	Frequency range (Mhz)			Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n41A-n79A	E-UTRA Band 1, 3, 5, 8, 9, 11, 18, 19, 21, 28, 34, 40, 42, 44, 45, 65 or NR Band n1, n3, n8, n28, n34, n40	FDL_low	-	FDL_high	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	1

NOTE 1: Applicable when co-existence with PHS system operating in 1884.5 -1915.7MHz.

6.10.2.2 REFSENS requirements

No specific REFENS requirements need to be specified.

6.11 CA_n5-n78

6.11.1 Common for 1 band UL and 2 bands UL CA

6.11.1.1 Operating bands for CA

Table 6.11.1.1-1: CA band combination

NR Band	Uplink (UL) band				Downlink (DL) band				Duplex mode	
	BS receive / UE transmit				BS transmit / UE receive					
	$F_{UL_low} - F_{UL_high}$				$F_{DL_low} - F_{DL_high}$					
n5	824 MHz – 849 MHz		869 MHz – 894 MHz						FDD	
n78	3300 MHz – 3800 MHz		3300 MHz – 3800 MHz						TDD	

6.11.1.2 Channel bandwidths per operating band for CA

Table 6.11.1.2-1: Supported bandwidths per CA band combination

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n5A-n78A	CA_n5A-n78A	n5	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60													
		n78	15		Yes	Yes	Yes				Yes	Yes				
			30		Yes	Yes	Yes				Yes	Yes	Yes	Yes	Yes	
			60		Yes	Yes	Yes				Yes	Yes	Yes	Yes	Yes	
CA_n5A-n78C	CA_n5A-n78A	n5	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60													
		n78	See CA_n78C Bandwidth Combination Set 0 in Table 5.5A.1-1 in 38.101-1													

6.11.1.3 Co-existence studies

Table 6.11.1.3-1 lists the 2nd, 3rd, 4th and 5th order harmonics for CA_n5-n78.

Table 6.11.1.3-1: Band n5 and Band n78 UL harmonics

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	824	849	3300	3800
2 nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2 nd harmonics frequency limits (MHz)	1648	1698	6600	7600
3 rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3 rd harmonics frequency limits (MHz)	2472	2547	9900	11400
4 th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4 th harmonics frequency limits (MHz)	3296	3396	13200	15200
5 th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5 th harmonics frequency limits (MHz)	4120	4245	16500	19000

Based on above table, the 4th harmonic of Band n5 may fall into Rx frequencies of Band n78, which may cause Band n78 desense.

6.11.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n5-n78, the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 6.11.1.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n5-n78	n5	0.6
	n78	0.8

Table 6.11.1.4-2: ΔR_{IB}

Inter-band DC Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n5-n78	n5	0.2
	n78	0.5

6.11.1.5 REFSENS requirements

Table 6.11.1.5-1 lists the MSD requirement due to the 4th harmonic of Band n5 for CA_n5-n78 by referring the endorsed TP of R4-1810167 for DC_5A-n78A.

Table 6.11.1.5-1: MSD due to 4th harmonic for CA_n5A-n78A

MSD due to harmonic exception for the DL band											
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz
		dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
n5	n78 ^{4,5}		10.5	8.9	7.8		5.4				

NOTE 4: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of a low band for which the 4th transmitter harmonic is within the downlink transmission bandwidth of a high band.

NOTE 5: The requirements should be verified for UL NR-ARFCN of a low band (superscript LB) such that

$$f_{UL}^{LB} = \left\lfloor f_{DL}^{HB} / 0.4 \right\rfloor 0.1$$

in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{HB} the carrier frequency of a high band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the low band.

Table 6.11.1.5-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for NR CA, FR1

UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz
n5	n78	8	16	25	25 ³ , 25 ⁴						

NOTE 3: The configuration is used for measurement of MSD for NR channel bandwidth of 20MHz.

NOTE 4: The configuration is used for measurement of MSD for NR channel bandwidth of 40MHz.

6.11.2 Specific for 2 bands UL CA

6.11.2.1 UE co-existence studies

Table 6.11.2.1-1 lists Band n5 +Band n78 2UL CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.11.2.1-1: Band n5 and Band n78 UL IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	824	849	3300	3800
2 nd order IMD products	fy_low - fx_high	fy_high - fx_low	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	2451	2976	4124	4649
Two-tone 3 rd order IMD products	2*fx_low - fy_high	2*fx_high - fy_low	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	2152	1602	5751	6776
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	4948	5498	7424	8449
Two-tone 3 rd order IMD products	(fx_low - max BW fy)	(fx_high + max BW fy)	(fy_low - max BW fx)	(fy_high + max BW fx)
IMD frequency limits (MHz)	724	949	3290	3810
Two-tone 4 th order IMD products	3*fx_low - 1*fy_high	3*fx_high - 1*fy_low	3*fy_low - 1*fx_high	3*fy_high - 1*fx_low
IMD frequency limits (MHz)	1328	753	9051	10576
Two-tone 4 th order IMD products	2*fx_low - 2*fy_high	2*fx_high - 2*fy_low		
IMD frequency limits (MHz)	5952	4902		
Two-tone 4 th order IMD products	3*fx_low + 1*fy_low	3*fx_high + 1*fy_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high
IMD frequency limits (MHz)	5772	6347	10724	12249
Two-tone 4 th order IMD products	2*fx_low + 2*fy_low	2*fx_high + 2*fy_high		
IMD frequency limits (MHz)	8248	9298		
Two-tone 5 th order IMD products	fx_low - 4*fy_high	fx_high - 4*fy_low	fy_low - 4*fx_high	fy_high - 4*fx_low
IMD frequency limits (MHz)	14376	12351	96	504
Two-tone 5 th order IMD products	2*fx_low - 3*fy_high	2*fx_high - 3*fy_low	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)	9752	8202	4053	5128
Two-tone 5 th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
IMD frequency limits (MHz)	14024	16049	6596	7196
Two-tone 5 th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	11548	13098	9072	10147

Based on Table 6.11.2.1-1, 4th order IMD may also fall into own Rx of band 5

Table 6.11.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.11.2.1-2: Protected bands for 2UL bands CA configuration

CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n5A_n78A	E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 10, 12, 13, 14, 17, 24, 25, 28, 29, 30, 31, 34, 38, 40, 42, 43, 45, 48, 65, 66, 70	F _{DL_low}	-	F _{DL_high}	-50	1
	E-UTRA Band 26	859	-	869	-27	1
	Frequency range	945	-	960	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3
	Frequency range	2545	-	2575	-50	1
	Frequency range	2595	-	2645	-50	1
	E-UTRA Band 41	F _{DL_low}	-	F _{DL_high}	-50	1
NOTE 3: Applicable when co-existence with PHS system operating in 1884.5 -1915.7 MHz						
NOTE 6: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.						

6.11.2.2 REFSENS requirements

Table 6.11.2.2-1 lists the MSD required for the dual uplink configuration.

Table 6.11.2.2-1: MSD due to IMD issue

E-UTRA and NR Band / Channel bandwidth / N _{RB} / Duplex mode								Source of IMD
DC Configuration	EUTRA and NR band	UL F _c (MHz)	UL/DL BW (MHz)	UL C _{LRB}	DL F _c (MHz)	MSD (dB)	Duplex mode	
DC_n5A_n78A	n5	844	5	25	889	8.3	FDD	IMD4 f _{B78} -3*f _{B5}
	n78	3421	10	50	3421	N/A	TDD	N/A

6.12 CA_n5-n79

6.12.1 Common for 1 band UL and 2 bands UL CA

6.12.1.1 Operating bands for CA

Table 6.12.1.1-1: CA band combination

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
	BS receive / UE transmit			BS transmit / UE receive				
	F _{UL_low} – F _{UL_high}			F _{DL_low} – F _{DL_high}				
n5	824 MHz – 849 MHz			869 MHz – 894 MHz			FDD	
n79	4400 MHz – 5000 MHz			4400 MHz – 5000 MHz			TDD	

6.12.1.2 Channel bandwidths per operating band for CA

Table 6.12.1.2-1: Supported bandwidths per CA band combination

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n5A-n79A	CA_n5A-n79A	n5	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60													
		n79	15							Yes	Yes					
			30							Yes	Yes	Yes	Yes		Yes	
			60							Yes	Yes	Yes	Yes		Yes	
CA_n5A-n79C	CA_n5A-n79A	n5	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60													
		n79	See CA_n79C Bandwidth Combination Set 0 in Table 5.5A.1-1 in 38.101-1													

6.12.1.3 Co-existence studies

Table 6.12.1.3-1 lists the 2nd, 3rd, 4th and 5th order harmonics for CA_n5-n79.

Table 6.12.1.3-1: Band n5 and Band n79 UL harmonics

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	824	849	4400	5000
2 nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2 nd harmonics frequency limits (MHz)	1648	1698	8800	10000
3 rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high

3 rd harmonics frequency limits (MHz)	2472	2547	13200	15000
4 th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4 th harmonics frequency limits (MHz)	3296	3396	17600	20000
5 th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5 th harmonics frequency limits (MHz)	4120	4245	22000	25000

Based on above table, there is no harmonic issue for this band combination.

6.12.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n5-n79, the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 6.12.1.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n5-n79	n5	0
	n79	0

Table 6.12.1.4-2: ΔR_{IB}

Inter-band DC Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n5-n79	n5	0
	n79	0

6.12.1.5 REFSENS requirements

Because of no harmonic falling into the own Rx Band, there is no MSD issue for this 1UL combination.

6.12.2 Specific for 2 bands UL CA

6.12.2.1 UE co-existence studies

Table 6.12.2.1-1 lists Band n5 +Band n79 2UL CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.12.2.1-1: Band n5 and Band n79 UL IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	824	849	4400	5000
Two tone 2 nd order IMD products	fy_low – fx_high	fy_high – fx_low	fx_low + fy_low	fx_high + fy_high
IMD frequency limits (MHz)	3551	4176	5224	5849
Two-tone 3 rd order IMD products	2*fx_low – fy_high	2*fx_high – fy_low	2*fy_low – fx_high	2*fy_high – fx_low
IMD frequency limits (MHz)	2702	3352	7951	9176
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	6048	6698	9624	10849
Two-tone 4 th order IMD products	3*fx_low – fy_high	3*fx_high – fy_low	3*fy_low – fx_high	3*fy_high – fx_low
IMD frequency limits (MHz)	1853	2528	12351	14176
Two-tone 4 th order IMD products	3*fx_low + fy_low	3*fx_high + fy_high	3*fy_low + fx_low	3*fy_high + fx_high
IMD frequency limits (MHz)	6872	7547	14024	15849
Two-tone 4 th order IMD products	2*fy_low – 2*fx_high	2*fy_high – 2*fx_low	2*fx_low + 2*fy_low	2*fx_high + 2*fy_high
IMD frequency limits (MHz)	7102	8352	10448	11698
Two-tone 5 th order IMD products	4*fx_low – fy_high	4*fx_high – fy_low	4*fy_low – fx_high	4*fy_high – fx_low
IMD frequency limits (MHz)	1004	1704	16751	19176
Two-tone 5 th order IMD products	4*fx_low + fy_low	4*fx_high + fy_high	4*fy_low + fx_low	4*fy_high + fx_high
IMD frequency limits (MHz)	7696	8396	18424	20849
Two-tone 5 th order IMD products	3*fx_low – 2*fy_high	3*fx_high – 2*fy_low	3*fy_low – 2*fx_high	3*fy_high – 2*fx_low
IMD frequency limits (MHz)	6253	7528	11502	13352
Two-tone 5 th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	14848	16698	11272	12547

Based on the above table, there is no IMD falling into own Rx band for this band combination.

Table 6.12.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.12.2.1-2: Protected bands for 2UL bands CA configuration

CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n5A_n79A	Bands 1, 2, 3, 4, 5, 7, 8, 10, 12, 13, 14, 17, 24, 25, 28, 29, 30, 31, 34, 38, 40, 42, 43, 45, 48, 50, 51, 65, 66, 70, 71, 73, 74, 85	F _{DL_low}	-	F _{DL_high}	-50	1
	E-UTRA Band 26	859	-	869	-27	1
	Bands 41, 52	F _{DL_low}	-	F _{DL_high}	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3
						3

NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of (2 MHz + N x LCRB x 180kHz), where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.

NOTE 3: Applicable when co-existence with PHS system operating in 1884.5 -1915.7 MHz

6.12.2.2 REFSENS requirements

Because of no IMD falling into the own Rx Band, there is no MSD issue for this 2UL combination.

6.13 CA_n40-n41

6.13.1 Common for 1 band UL and 2 bands UL

6.13.1.1 Operating bands for CA

Table 6.13.1.1-1: CA band combination of band n40+n41

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode
	BS receive / UE transmit		F _{UL_low} – F _{UL_high}	BS transmit / UE receive		F _{DL_low} – F _{DL_high}	
	2300 MHz	–	2400 MHz	2300 MHz	–	2400 MHz	
n40	2300 MHz	–	2400 MHz	2300 MHz	–	2400 MHz	TDD
n41	2496 MHz	–	2690 MHz	2496 MHz	–	2690 MHz	TDD

6.13.1.2 Channel bandwidths per operating band for CA

Table 6.13.1.2-1: Supported bandwidths per CA band combination of band n40+n41

CA operating / channel bandwidth [MHz]																0
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	
CA_n40A-n41A	CA_n40A-n41A	n40	15	Yes												
			30		Yes											
			60		Yes											
		n41	15		Yes	Yes	Yes			Yes	Yes					
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
		n40	15	Yes												
			30		Yes	Yes	Yes	Yes	Yes	Yes						
			60		Yes	Yes	Yes	Yes	Yes	Yes						
		n41	15		Yes	Yes	Yes			Yes	Yes					
			30		Yes	Yes	Yes			Yes	Yes					
			60		Yes	Yes	Yes			Yes	Yes					

6.13.1.3 UE co-existence studies

Table 6.13.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n40-n41.

Table 6.13.1.3-1: Impact of UL/DL Harmonic

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	2nd Harmonic			3rd Harmonic		nth Harmonic	
				DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n40	2300	2400	2300	2400	4600	4800	6900	7200		
n41	2496	2690	2496	2690	4992	5380	7488	8070		

Based on above table, there is no harmonic issue for the band combination of n40 and n41.

Table 6.13.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic		3rd Harmonic		mth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n40	2300	2400	2300	2400	4600	4800	6900	7200		
n41	2496	2690	2496	2690	4992	5380	7488	8070		

Based on above table, there is no harmonic mixing issue for the band combination of n40 and n41.

6.13.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n40-n41, the $T_{IB,c}$ and $R_{IB,c}$ values for UEs not supporting simultaneous Rx/Tx are given in the tables below.

Table 6.13.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n40-n41	n40	0.5
	n41	0.5

NOTE 1: Applicable for UE supporting inter-band carrier aggregation without simultaneous Rx/Tx.

Table 6.13.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n40-n41	n40	0
	n41	0

NOTE 1: Applicable for UE supporting inter-band carrier aggregation without simultaneous Rx/Tx.

6.13.1.5 REFSENS requirements

Since the focus of this combination is not supporting simultaneous Tx/Rx, there are no specific REFSENS requirements for 1 band UL.

6.13.2 Specific for 2 bands UL CA

6.13.2.1 UE co-existence studies

Table 6.13.2.1-1 lists Band n40 + Band n41 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.13.2.1-1: Band n40 and Band n41 2UL bands IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	2300	2400	2496	2690
2 nd order IMD products	fy_low - fx_high	fy_high - fx_low	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	96 - 390		4796 - 5090	
Two-tone 3 rd order IMD products	2*fx_low - fy_high	2*fx_high - fy_low	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	1910 - 2304		2592 - 3080	
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	7096 - 7490		7292 - 7780	
Two-tone 3 rd order IMD products	(fx_low - max BW fy)	(fx_high + max BW fy)	(fy_low - max BW fx)	(fy_high + max BW fx)
IMD frequency limits (MHz)	2200 - 2500		2416 - 2770	
Two-tone 4 th order IMD products	3*fx_low - 1*fy_high	3*fx_high - 1*fy_low	3*fy_low - 1*fx_high	3*fy_high - 1*fx_low
IMD frequency limits (MHz)	4210 - 4704		5088 - 5770	
Two-tone 4 th order IMD products	2*fx_low - 2*fy_high	2*fx_high - 2*fy_low		
IMD frequency limits (MHz)	192 - 780			
Two-tone 4 th order IMD products	3*fx_low + 1*fy_low	3*fx_high + 1*fy_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high
IMD frequency limits (MHz)	9396 - 9890		9788 - 10470	
Two-tone 4 th order IMD products	2*fx_low + 2*fy_low	2*fx_high + 2*fy_high		
IMD frequency limits (MHz)	9592 - 10180			
Two-tone 5 th order IMD products	fx_low - 4*fy_high	fx_high - 4*fy_low	fy_low - 4*fx_high	fy_high - 4*fx_low
IMD frequency limits (MHz)	7584 - 8460		6510 - 7104	
Two-tone 5 th order IMD products	2*fx_low - 3*fy_high	2*fx_high - 3*fy_low	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)	2688 - 3470		1520 - 2208	
Two-tone 5 th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
IMD frequency limits (MHz)	12284 - 13160		11696 - 12290	
Two-tone 5 th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	12088 - 12870		11892 - 12580	

NOTE : For each IMD item, when two bound values before taking absolute have different signs, the relevant IMD range shall be set such that (1) the lower bound is 0 and (2) the upper bound is the bigger value of the two after taking absolute.

As IMD is not an issue for TDD bands combination, there is no MSD issue for this band combination. In addition, since only synchronized operation without supporting simultaneous Tx/Rx is considered for this combination, no MSD due to cross band isolation need to be specified.

Table 6.13.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.13.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n40-n41	E-UTRA Band 1, 3, 5, 8, 26, 27, 28, 34, 39, 42, 44, 45, 50, 51, 65, 73, 74, NR Band n77, n78	F_{DL_low}	-	F_{DL_high}	-50	1
	NR Band n79	F_{DL_low}	-	F_{DL_high}	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3
NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2\text{MHz} + N \times \text{LCRB} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.						
NOTE 3: Applicable when co-existence with PHS system operating in 1884.5 -1915.7MHz.						
NOTE x: This requirement applies when the NR carriers are confined within 2545-2575 MHz or 2595-2645 MHz and the channel bandwidth is 10 or 20 MHz						

NOTE: All the tables mentioned in the note of above table are specified in TS38.101-1.

6.13.2.2 REFSENS requirements

As IMD is not an issue for TDD bands combination, there is no MSD issue for this combination.

6.14 CA_n70-n71

6.14.1 Common for 1 band UL and 2 bands UL CA

6.14.1.1 Operating bands for CA

Table 6.14.1.1-1: CA band combination of band n70+n71

NR Band	Uplink (UL) band	Downlink (DL) band	Duplex mode
	BS receive / UE transmit	BS transmit / UE receive	
	$F_{UL_low} - F_{UL_high}$	$F_{DL_low} - F_{DL_high}$	
n70	1695 – 1710	1995 – 2020	FDD
n71	663 – 698	617 – 652	FDD

6.14.1.2 Channel bandwidths per operating band for CA

Table 6.14.1.2-1: Supported bandwidths per CA band combination of band n70+n71

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n70A-n71A	CA_n70A-n71A	n70	15	Yes	Yes	Yes	Yes ¹	Yes ¹								0
			30		Yes	Yes	Yes ¹	Yes ¹								
			60		Yes	Yes	Yes ¹	Yes ¹								
		n71	15	Yes	Yes	Yes	Yes									
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									

NOTE 1: This UE channel bandwidth is applicable only to downlink.

6.14.1.3 UE co-existence studies

Table 6.14.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA _ n70-n71.

Table 6.14.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		nth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n70	1695	1710	1995	2020	3390	3420	5085	5130		
n71	663	698	617	652	1326	1396	1989	2094		

Based on the table above, the 3rd harmonic of n71 UL lands on top of n70 DL.

Table 6.14.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic		3rd Harmonic		mth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n70	1695	1710	1995	2020	3990	4040	5985	6060		
n71	663	698	617	652	1234	1304	1851	1956		

Based on the table above, there is no harmonic mixing relation.

6.14.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n70-n71, the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 6.14.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n70-n71	n70	0.3
	n71	0.6

Table 6.14.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n70-n71	n70	0
	n71	0

6.14.1.5 REFSENS requirements

Table 6.14.1.5-1: Reference sensitivity exceptions due to UL harmonic for NR CA FR1

MSD due to harmonic exception for the DL band													
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
		dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
n71	n70 ^{1,2}	9.9	7.1	6.7	4.9	4.1							

NOTE 1: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (lower) band for which the 3rd transmitter harmonic is within the downlink transmission bandwidth of a victim (higher) band.

NOTE 2: The requirements should be verified for UL NR-ARFCN of the aggressor (lower) band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.3 \rfloor 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{HB} carrier frequency in the victim (higher) band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the lower band.

Table 6.14.1.5-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for NR CA, FR1

NR Band / Channel bandwidth of the high band													
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n71	n70	8	16	20	20	20							

NOTE: 15kHz SCS is assumed for UL band.

6.14.2 Specific for 2 bands UL CA

6.14.2.1 UE co-existence studies

Table 6.14.2.1-1: Impact of Intermodulations

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	1695	1710	663	698
Two tone 2 nd order IMD products	fy_low – fx_high	fy_high – fx_low	fx_low + fy_low	fx_high + fy_high
IMD frequency limits (MHz)	1047	997	2358	2408
Two-tone 3 rd order IMD products	2*fx_low – fy_high	2*fx_high – fy_low	2*fy_low – fx_high	2*fy_high – fx_low
IMD frequency limits (MHz)	2692	2757	384	299
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	4053	4118	3021	3106
Two-tone 4 th order IMD products	3*fx_low – fy_high	3*fx_high – fy_low	3*fy_low – fx_high	3*fy_high – fx_low
IMD frequency limits (MHz)	4387	4467	279	399

Two-tone 4 th order IMD products	$3*fx_low + fy_low$	$3*fx_high + fy_high$	$3*fy_low + fx_low$	$3*fy_high + fx_high$
IMD frequency limits (MHz)	5748	5828	3021	3804
Two-tone 4 th order IMD products	$2*fy_low - 2*fx_high$	$2*fy_high - 2*fx_low$	$2*fx_low + 2*fy_low$	$2*fx_high + 2*fy_high$
IMD frequency limits (MHz)	2094	1994	4716	4816
Two-tone 5 th order IMD products	$ 4*fx_low - fy_high $	$ 4*fx_high - fy_low $	$4*fy_low - fx_high$	$4*fy_high - fx_low$
IMD frequency limits (MHz)	6082	6177	942	1097
Two-tone 5 th order IMD products	$4*fx_low + fy_low$	$4*fx_high + fy_high$	$4*fy_low + fx_low$	$4*fy_high + fx_high$
IMD frequency limits (MHz)	7443	7538	4347	4502
Two-tone 5 th order IMD products	$ 3*fx_low - 2*fy_high $	$ 3*fx_high - 2*fy_low $	$3*fy_low - 2*fx_high$	$3*fy_high - 2*fx_low$
IMD frequency limits (MHz)	3689	3804	1431	1296
Two-tone 5 th order IMD products	$2*fx_low + 3*fy_low$	$2*fx_high + 3*fy_high$	$2*fy_low + 3*fx_low$	$2*fy_high + 3*fx_high$
IMD frequency limits (MHz)	5379	5514	6411	6526

Based on the table above, there is IMD4 falling on top of n70 DL. There is pretty similar combination in EN-DC, DC_66A_n71A with same IMD source ($2*66$ UL- $2*71$ UL= 66 DL) where MSD is defined for B66. Because the IMD mechanisms are exactly the same, we propose to reuse that MSD number for n70 recognizing MSD for n70 is not fully optimized as in CA_n70A-n71A MSD hits only partially on top of n70 while in DC_66A_n71A there is full hit.

Furthermore, the 3rd harmonic relation has MSD specified for n70, but the frequency arrangement for IMD4 is such that the 3rd harmonic does not occur at n70 in IMD4 requirement.

Table 6.14.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.14.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA combination	Spurious emission					
	Protected Band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n70-n71	E-UTRA Band 4, 5, 7, 10, 12, 13, 14, 17, 26, 27, 30, 48, 66, 74, 85	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 2, 25, 41, 70	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 29	F_{DL_low}	-	F_{DL_high}	-38	1
	E-UTRA Band 71	F_{DL_low}	-	F_{DL_high}	-50	1
<p>NOTE 1: F_{DL_low} and F_{DL_high} refer to each frequency band specified in Table 5.2-1 in TS 38.101-1 or Table 5.5-1 in TS 36.101</p> <p>NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2 \text{ MHz} + N \times L_{CRB} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.</p> <p>NOTE 4: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.</p>						

6.14.2.2 REFSENS requirements

MSD is defined for n70 as follows.

Table 6.14.2.2-1: 2DL/2UL interband Reference sensitivity QPSK PREFSENS and uplink/downlink configurations

NR CA Configuration	NR band	UL F_c (MHz)	UL/DL BW (MHz)	UL C_{LRB}	DL F_c (MHz)	MSD (dB)	Duplex mode	Source of IMD
CA_n70A-n71A	n70	1697.5	5	25	1997.5	5	FDD	IMD4
	n71	695.5	5	25	649.5	N/A	FDD	N/A

6.15 CA_n50-n78

6.15.1 Common for 1 band UL and 2 bands UL CA

6.15.1.1 Operating bands for CA

Table 6.15.1-1: DC band combination of bands n50+n78

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode		
	BS receive / UE transmit		BS transmit / UE receive				
	$F_{UL_low} - F_{UL_high}$		$F_{DL_low} - F_{DL_high}$				
n50	1432 MHz	–	1517 MHz	1432 MHz	–	1517 MHz	TDD
n78	3300 MHz	–	3800 MHz	3300 MHz	–	3800 MHz	TDD

6.15.1.2 Channel bandwidths per operating band for CA

Table 6.15.1.2-1: Supported bandwidths per CA band combination of bands n50+n78

NR CA Configuration	UL Configuration	NR Band	SC S kHz	CA operating / channel bandwidth [MHz]												Bandwidth combination set
				5	10	15	20	25	30	40	50	60	80	90	100	
CA_n50A-n78A	CA_n50A-n78A	n50	15	Yes	Yes	Yes	Yes		Yes	Yes	Yes					0
			30		Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes ¹			
			60		Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes ¹			
		n78	15		Yes	Yes	Yes			Yes	Yes					
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	

NOTE 1: This UE channel bandwidth is applicable only to downlink.

6.15.1.3 Co-existence studies

Table 6.15.1.3 summarizes frequency ranges where harmonics occur for CA_n50-n78.

Table 6.15.1.3: Impact of UL/DL Harmonic

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2nd Harmonic		3rd Harmonic		nth Harmonic	
					UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n50	1432	1517	1432	1517	2864	3034	4296	4551		
n78	3300	3800	3300	3800	6600	7600	9900	11400		

Based on above table, there is a no harmonic issue for this band combination.

6.15.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n50_n78, the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 6.15.1.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
CA_n50_n78	n50	0 ¹
	n78	0 ¹
	n50	0.5 ²
	n78	0.5 ²

NOTE 1: Only applicable for UE supporting inter-band carrier aggregation with uplink in one NR band and without simultaneous Rx/Tx.

NOTE 2: Applicable for UE supporting inter-band carrier aggregation without simultaneous Rx/Tx.

Table 6.15.1.4-2: ΔR_{IB} ,c

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
CA_n50_n78	n50	0.2 ¹
	n78	0.2 ¹
	n50	0.2 ²
	n78	0.2 ²
NOTE 1: Only applicable for UE supporting inter-band carrier aggregation with uplink in one NR band and without simultaneous Rx/Tx.		
NOTE 2: Applicable for UE supporting inter-band carrier aggregation without simultaneous Rx/Tx.		

6.15.1.5 REFSENS requirements

There are no specific REFSENS requirements

6.15.2 Specific for 2 bands UL CA

6.15.2.1 UE co-existence studies

Table 6.15.2.1-1 lists Bands n50 +Band n78 2UL CA 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.15.2.1-1: Band n28 and Band n50 UL harmonic and IMD analysis

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	1432	1517	3300	3800
Two tone 2nd order IMD products	$(fx_low - fy_high)$	$(fx_high - fy_low)$	$(fx_low + fy_low)$	$(fx_high + fy_high)$
IMD frequency limits (MHz)	1783	2368	4732	5317
Two-tone 3rd order IMD products	$ 2*fx_low - fy_high $	$ 2*fx_high - fy_low $	$(2*fx_low - fy_high)$	$(2*fx_high - fy_low)$
IMD frequency limits (MHz)	266	936	5083	6168
Two-tone 3rd order IMD products	$(2*fx_low + fy_low)$	$(2*fx_high + fy_high)$	$(2*fx_low + fy_low)$	$(2*fx_high + fy_high)$
IMD frequency limits (MHz)	6164	6834	8032	9117
3rd order IMD products	$(fx_low - fy_high + fy_low)$	$(fx_high + fy_high - fy_low)$	$(fy_low - fx_high + fx_low)$	$(fy_high + fx_high - fx_low)$
	932	2017	3215	3885
Two-tone 3rd order IMD products	$(fx_low - \max BW fy)$	$(fx_high + \max BW fy)$	$(fy_low - \max BW fx)$	$(fy_high + \max BW fx)$
IMD frequency limits (MHz)	1332	1617	3240	3860
Two-tone 4th order IMD products	$ 3*fx_low - fy_high $	$ 3*fx_high - fy_low $	$(3*fy_low - fx_high)$	$(3*fy_high - fx_low)$

IMD frequency limits (MHz)	496	1251	8383	9968
Two-tone 4th order IMD products	$(2*fy_low - 2*fx_high)$	$(2*fy_high - 2*fx_low)$		
IMD frequency limits (MHz)	3566	4736		
Two-tone 4th order IMD products	$(3*fx_low + fy_low)$	$(3*fx_high + fy_high)$	$(3*fy_low + fx_low)$	$(3*fy_high + fx_high)$
IMD frequency limits (MHz)	7596	8351	11332	12917
Two-tone 4th order IMD products	$(2*fx_low + 2*fy_low)$	$(2*fx_high + 2*fy_high)$		
IMD frequency limits (MHz)	9464	10634		
Two-tone 5 th order IMD products	$(4*fy_low - fx_high)$	$(4*fy_high - fx_low)$	$ 4*fx_low - fy_high $	$ 4*fx_high - fy_low $
IMD frequency limits (MHz)	11683	13768	1928	2768
Two-tone 5 th order IMD products	$(3*fy_low - 2*fx_high)$	$(3*fy_high - 2*fx_low)$	$ 2*fy_low - 3*fx_high $	$ 2*fy_high - 3*fx_low $
IMD frequency limits (MHz)	6866	8536	2049	3304
Two-tone 5 th order IMD products	$(4*fy_low + fx_low)$	$(4*fy_high + fx_high)$	$(4*fx_low + fy_low)$	$(4*fx_high + fy_high)$
IMD frequency limits (MHz)	14632	16717	9028	9868
Two-tone 5 th order IMD products	$(3*fy_low + 2*fx_low)$	$(3*fy_high + 2*fx_high)$	$(3*fx_low + 2*fy_low)$	$(3*fx_high + 2*fy_high)$
IMD frequency limits (MHz)	12764	14434	10896	12151

Based on the table 6.1.15.2.1-1:

- 3rd order harmonic products may also fall into Rx frequencies of bands n79
- 2nd IMD products may also fall into Rx frequencies of bands 1/n1, 2/n2, 3/n3, 4, 9, 10, 23, 25/n25, 30, 34/n34, 35, 36, 37, 39/n39, 40/n40, 46, 65/n65, 66/n66, 70/n70, n79
- 3rd IMD products may also fall into Rx frequencies of bands 2/n2, 5/n5, 6, 8/n8, 9, 11, 12/n12, 13, 14, 17, 18, 19, 20/n20, 21, 22, 24, 25/n25, 26, 27, 28/n28, 31, 32, 33, 34, 35, 36, 37, 39/n39, 42, 43, 45, 46, 50/n50, 51/n51, 67, 68, 70/n70, 71/n71, 74/n74, 75/n75, 76/n76, n77, n78, 85
- 4th IMD products may also fall into Rx frequencies of bands 5/n5, 6, 8/n8, 12/n12, 13, 14, 17, 18, 19, 20/n20, 22, 26, 27, 28/n28, 29, 42, 43, 44, 67, 68, 71/n71, n77, n78, n79, 85
- 5th IMD products may also fall into Rx frequencies of bands 1/n1, 2/n2, 4, 7/n7, 10, 23, 25/n25, 30, 34/n34, 36, 37, 38/n38, 40/n40, 41/n41, 65/n65, 66/n66, 69, 70/n70, n77, n78,

Tables below list the protected bands for the dual connectivity configuration due to IMD, 3, 4 and 5.

Table 6.15.2.1-2: Protected bands for the 2UL bands CA configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band		Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n50A_n78A	E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 10, 12, 13, 17, 20, 25, 26, 27, 28, 29, 31, 33, 34, 38, 39, 40, 41, 44, 48, 65, 66, 67, 68, 69, 72, 73, 85 NR Band n1, n2, n3, n5, n7, n8, n12, n20, n25, n28, n34, n38, n39, n40, n41, n65, n66, n79	F_{DL_low}	-	F_{DL_high}	-50	1	

6.16 CA_n28-n50

6.16.1 Common for 1 band UL and 2 bands UL CA

6.16.1.1 Operating bands for CA

Table 6.16.1-1: CA band combination of bands n28-n50

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
	BS receive / UE transmit			BS transmit / UE receive				
	$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$				
n28	703 MHz – 748 MHz			758 MHz – 803 MHz			FDD	
n50	1432 MHz – 1517 MHz			1432 MHz – 1517 MHz			TDD	

6.16.1.2 Channel bandwidths per operating band for CA

Table 6.16.1.2-1: Supported bandwidths per CA band combination of bands n28-n50

CA operating / channel bandwidth [MHz]																0
NR CA Configuration	UL Configuration	NR Band	SC S kHz	5	10	15	20	25	30	40	50	60	80	90	100	
CA_n28A-n50A	CA_n28A-n50A	n28	15	Yes	Yes	Yes	Yes									
			30		Yes	Yes	Yes									
			60													
		n50	15	Yes	Yes	Yes	Yes			Yes	Yes					
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes ¹			
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes ¹		

NOTE 1: This UE channel bandwidth is applicable only to downlink.

6.16.1.3 Co-existence studies

Table 6.16.1.3 summarizes frequency ranges where harmonics occur for CA_n28-n50.

Table 6.16.1.3: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		nth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n28	703	748	758	803	1406	1496	2109	2244		
n50	1432	1517	1432	1517	2864	3034	4296	4551		

Based on above table, there is a possible harmonic issue for the band combination of n28 and n50 in the band n50.

6.16.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n28-n50, the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 6.16.1.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
CA_n28-n50	n28	0.3
	n50	0.4

Table 6.16.1.4-2: $\Delta R_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
CA_n28-n50	n28	0
	n50	0

6.16.1.5 Self-interference analysis

There is no harmonic or IMD in the case of the UL n50 is used alone.

For this combinations, sensitivity degradation is allowed for a band if it is impacted by UL of another band part of the same DC configuration due to UL harmonic interference issues. Reference sensitivity exceptions are specified in Table 6.16.1.5-1 with uplink configuration specified in Table 6.16.1.5-2.

Table 6.16.1.5-1: Reference sensitivity exceptions due to UL harmonic

UL band	DL band	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	30 MHz (dB)	40 MHz (dBm)	50 MHz (dBm)	60 MHz (dBm)	80 MHz (dBm)	90 MHz (dBm)	100 MHz (dBm)
n28	n50 ^{1,2}		19.8	18.0	16.8			13.8	12.8	12.0	10.8		

NOTE 1: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (lower) band for which the 2nd transmitter harmonic is within the downlink transmission bandwidth of a victim (higher) band.

NOTE 2: The requirements should be verified for UL NR-ARFCN of the aggressor (lower) band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.2 \rfloor + 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{HB} carrier frequency in the victim (higher) band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the lower band.

Table 6.16.1.5-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for NR CA, FR1

NR Band / Channel bandwidth of the high band														
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	
n28	n50		25	25	25			25	25	25	25			

NOTE 1: 15 kHz SCS is assumed for UL band.
 NOTE 2: The UL configuration applies regardless of the channel bandwidth of the low band unless the UL resource blocks exceed that specified in Table 7.3.2-3 for the uplink bandwidth in which case the allocation according to Table 7.3.2-3 applies.

6.16.2 Specific for 2 bands UL CA

6.16.2.1 UE co-existence studies

Table 6.16.2.1-1 lists Bands n28 and Band n50 2UL CA 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.16.2.1-1: Band n28 and Band n50 UL harmonic and IMD analysis

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	703	748	1432	1517
Two tone 2nd order IMD products	(fx_low – fy_high)	(fx_high – fy_low)	(fx_low + fy_low)	(fx_high + fy_high)
IMD frequency limits (MHz)	684	814	2135	2265
Two-tone 3rd order IMD products	2*fx_low – fy_high	2*fx_high – fy_low	(2*fx_low – fy_high)	(2*fx_high – fy_low)
IMD frequency limits (MHz)	64	111	2116	2331
Two-tone 3rd order IMD products	(2*fx_low + fy_low)	(2*fx_high + fy_high)	(2*fx_low + fy_low)	(2*fx_high + fy_high)
IMD frequency limits (MHz)	2838	3013	3567	3782
3rd order IMD products	(fx_low – fy_high + fy_low)	(fx_high + fy_high – fy_low)	(fy_low – fx_high + fx_low)	(fy_high + fx_high – fx_low)
	618	833	1387	1562
Two-tone 3rd order IMD products	(fx_low – max BW fy)	(fx_high + max BW fy)	(fy_low – max BW fx)	(fy_high + max BW fx)
IMD frequency limits (MHz)	643	808	1412	1537
Two-tone 4th order IMD products	3*fx_low – fy_high	3*fx_high – fy_low	(3*fy_low – fx_high)	(3*fy_high – fx_low)
IMD frequency limits (MHz)	592	812	3548	3848
Two-tone 4th order IMD products	(2*fy_low – 2*fx_high)	(2*fy_high – 2*fx_low)		

IMD frequency limits (MHz)	1368	1628		
Two-tone 4th order IMD products	(3*fx_low + fy_low)	(3*fx_high + fy_high)	(3*fy_low + fx_low)	(3*fy_high + fx_high)
IMD frequency limits (MHz)	3541	3761	4999	5299
Two-tone 4th order IMD products	(2*fx_low + 2*fy_low)	(2*fx_high + 2*fy_high)		
IMD frequency limits (MHz)	4270	4530		
Two-tone 5 th order IMD products	(4*fy_low - fx_high)	(4*fy_high - fx_low)	4*fx_low - fy_high	4*fx_high - fy_low
IMD frequency limits (MHz)	4980	5365	1295	1560
Two-tone 5 th order IMD products	(3* fy_low - 2*fx_high)	(3*fy_high - 2*fx_low)	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)	2800	3145	620	925
Two-tone 5 th order IMD products	(4*fy_low + fx_low)	(4*fy_high + fx_high)	(4*fx_low + fy_low)	(4*fx_high + fy_high)
IMD frequency limits (MHz)	6431	6816	4244	4509
Two-tone 5 th order IMD products	(3*fy_low + 2*fx_low)	(3*fy_high + 2*fx_high)	(3*fx_low + 2*fy_low)	(3*fx_high + 2*fy_high)
IMD frequency limits (MHz)	5702	6047	4973	5278

Based on the table 6.16.2.1-1:

- 2nd order harmonic products may also fall into Rx frequencies of bands 11, 21, 32, 45, 50/n50, 51/n51, 74/n74, 75/n75, 76/n76
- 3rd order harmonic products may also fall into Rx frequencies of bands 1/n1, 4, 10, 23, 65/n65, 66/n66, n79
- 2nd IMD products may also fall into Rx frequencies of bands 1/n1, 4, 10, 12/n12, 13, 14, 17, 20/n20, 23, 28/n28, 29, 44, 65/n65, 66/n66, 67, 68, 85
- 3rd IMD products may also fall into Rx frequencies of bands 1/n1, 4, 10, 11, 12/n12, 13, 14, 17, 20/n20, 21, 22, 23, 24, , 29, 32, 40/n40, 42, 43, 44, 45,, 51/n51, 65/n65, 66/n66, 67, 68, 71/n71, 74, n74, 75/n75, 76/n76, n77, n78 85
- 4th IMD products may also fall into Rx frequencies of bands 11, 12/n12, 13, 14, 17, 19, 20/n20, 21, 22, 24, 28/n28, 29, 32, 42, 43, 44, 45, 46, 50/n50, 51/n51, 67, 68, 71/n71, 74/n74, 75/n75, 76/n76, n77, n79, 85
- 5th IMD products may also fall into Rx frequencies of bands, 5/n5, 6, 11, 12/n12, 13, 14, 17, 18, 19, 20/n20, 21, 24, 26, 27, 28/n28, 29, 32, 44, 45, 46, 50/n50, 51/n51, 67, 68, 71/n71, 74/n74, 75/n75, 76/n76, n79, 85

Table 6.16.2.1-2 lists the protected bands required for the 2UL bands CA configuration

Table 6.16.2.1-2: Protected bands for the 2UL bands CA configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE	
CA_n28A_n50A	E-UTRA Band 4, 10, 12, 13, 17, 22, 42, 43, 52, 65, 66, 73 NR Band n65, n66, n77, n78	F _{DL_low}	-	F _{DL_high}	-50	1	2
	E-UTRA Band 1 NR band n1	F _{DL_low}	-	F _{DL_high}	-50	1	19, 25
	E-UTRA Band 2, 3, 5, 7, 8, 18, 19, 25, 26, 27, 29, 31, 34, 38, 39, 40, 41, 48, 52, 67, 72, 85 NR Band n5, n40 n79	F _{DL_low}	-	F _{DL_high}	-50	1	
	Frequency range	470	-	694	-42	8	15, 35
	Frequency range	470	-	710	-26.2	6	34
	Frequency range	662	-	694	-26.2	6	15
	Frequency range	758	-	773	-32	1	15
	Frequency range	773	-	803	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	8, 19
NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of (2MHz + N x LCRB x 180kHz), where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.							
NOTE 8: Applicable when co-existence with PHS system operating in 1884.5 -1915.7MHz.							
NOTE 15: These requirements also apply for the frequency ranges that are less than F _{OOB} (MHz) in Table 6.5.3.1-1 and Table 6.5.3.1-2 from the edge of the channel bandwidth.							
NOTE 19: Applicable when the assigned NR carrier is confined within 718 MHz and 748 MHz and when the channel bandwidth used is 5 or 10 MHz.							
NOTE 25: As exceptions, measurements with a level up to the applicable requirement of -36 dBm/MHz is permitted for each assigned NR carrier used in the measurement due to 3 rd harmonic spurious emissions. An exception is allowed if there is at least one individual RB within the transmission bandwidth (see Figure 5.3.1-1) for which the 3 rd harmonic totally or partially overlaps the measurement bandwidth (MBW).							
NOTE 34: This requirement is applicable for 5 and 10 MHz NR channel bandwidth allocated within 718-728MHz. For carriers of 10 MHz bandwidth, this requirement applies for an uplink transmission bandwidth less than or equal to 30 RB with RBstart > 1 and RBstart<48.							
NOTE 35: This requirement is applicable in the case of a 10 MHz NR carrier confined within 703 MHz and 733 MHz, otherwise the requirement of -25 dBm with a measurement bandwidth of 8 MHz applies.							

6.16.2.2 REFSENS requirements

It may have 2nd, 4th, 5th order IMDs when the UP of the band n28 and the UP of the band n50 is used in the same time without precaution.

Table 6.16.2.2-1 lists the MSD required for the dual connectivity configuration CA_n28A-n50A.

Table 6.16.2.2-1: MSD due to IMD issue

E-UTRA and NR Band / Channel bandwidth / N _{RB} / Duplex mode / MSD / Single UL									
CA Configuration	EUTRA and NR band	UL F _c (MHz)	UL/DL BW (MHz)	UL C _{LRB}	DL F _c (MHz)	MSD (dB)	Duplex mode	IMD order	Single UL allowed
CA_n28A-n50A	n28	730	10	50	775	15.3	FDD	IMD2	
	n50	1500	10	50	1500	N/A	TDD	N/A	
CA_n28A-n50A	n28	740	10	50	785	6	FDD	IMD4	
	n50	1500	10	50	1500	N/A	TDD	N/A	
CA_n28A-	n28	740	10	50	785	0.5	FDD	IMD5	

n50A	n50	1500	60	50	1500	N/A	TDD	N/A	
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6.17 CA_n41-n50

6.17.1 Common for 1 band UL and 2 bands UL CA

6.17.1.1 Operating bands for CA

Table 6.17.1-1: DC band combination of bands n41+n50

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
	BS receive / UE transmit			BS transmit / UE receive				
	$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$				
n41	2496 MHz – 2690 MHz			2596 MHz – 2690 MHz			TDD	
n50	1432 MHz – 1517 MHz			1432 MHz – 1517 MHz			TDD	

6.17.1.2 Channel bandwidths per operating band for CA

Table 6.17.1.2-1: Supported bandwidths per CA band combination of bands n41+n50

CA operating / channel bandwidth [MHz]

NR CA Configuration	UL Configuration	NR Band	SC S kHz	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n41A-n50A	CA_n41A-n50A	n41	15		Yes	Yes	Yes		Yes	Yes	Yes					0
			30		Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	
			60		Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	
		n50	15	Yes	Yes	Yes	Yes			Yes	Yes					
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes ¹		
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes ¹		

NOTE 1: This UE channel bandwidth is applicable only to downlink.

6.17.1.3 Co-existence studies

Table 6.17.1.3 summarizes frequency ranges where harmonics occur for CA_n41-n50.

Table 6.17.1.3: Impact of UL/DL Harmonic

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2nd Harmonic		3rd Harmonic		nth Harmonic	
					UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n41	2496	2690	2496	2690	4992	5380	7488	8070		
n50	1432	1517	1432	1517	2864	3034	4296	4551		

Based on above table, there is no harmonic issue for the band combination of n41 and n50 in the bands n41 and n50.

6.17.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n41-n50, the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 6.17.1.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
CA_n41-n50	n41	0.3
	n50	0.4

Table 6.17.1.4-2: $\Delta R_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
CA_n41-n50	n41	0
	n50	0

6.17.1.5 REFSENS requirements

There are no specific REFSENS requirements

6.17.2 Specific for 2 bands UL CA

6.17.2.1 UE co-existence studies

Table 6.17.2.1-1 lists Bands n41 + Band n50 2UL CA 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.17.2.1-1: Band n28 and Band n50 UL harmonic and IMD analysis

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	2496	2690	1432	1517
Two tone 2nd order IMD products	$(fx_low - fy_high)$	$(fx_high - fy_low)$	$(fx_low + fy_low)$	$(fx_high + fy_high)$
IMD frequency limits (MHz)	1258	979	3928	4207
Two-tone 3rd order IMD products	$ 2*fx_low - fy_high $	$ 2*fx_high - fy_low $	$(2*fx_low - fy_high)$	$(2*fx_high - fy_low)$
IMD frequency limits (MHz)	3475	3948	174	538
Two-tone 3rd order IMD products	$(2*fx_low + fy_low)$	$(2*fx_high + fy_high)$	$(2*fx_low + fy_low)$	$(2*fx_high + fy_high)$
IMD frequency limits (MHz)	6424	6897	5360	5724
3rd order IMD products	$(fx_low - fy_high + fy_low)$	$(fx_high + fy_high - fy_low)$	$(fy_low - fx_high + fx_low)$	$(fy_high + fx_high - fx_low)$
Two-tone 3rd order IMD products	2411 $(fx_low - \max BW fy)$	2775 $(fx_high + \max BW fy)$	1238 $(fy_low - \max BW fx)$	1711 $(fy_high + \max BW fx)$
IMD frequency limits (MHz)	2436	2750	1332	1617
Two-tone 4th order IMD products	$ 3*fx_low - fy_high $	$ 3*fx_high - fy_low $	$(3*fy_low - fx_high)$	$(3*fy_high - fx_low)$

IMD frequency limits (MHz)	5971	6638	1606	2055
Two-tone 4th order IMD products	(2*fy_low – 2*fx_high)	(2*fy_high – 2*fx_low)		
IMD frequency limits (MHz)	2516	1958		
Two-tone 4th order IMD products	(3*fx_low + fy_low)	(3*fx_high + fy_high)	(3*fy_low + fx_low)	(3*fy_high + fx_high)
IMD frequency limits (MHz)	8920	9587	6792	7241
Two-tone 4th order IMD products	(2*fx_low + 2*fy_low)	(2*fx_high + 2*fy_high)		
IMD frequency limits (MHz)	7856	8414		
Two-tone 5 th order IMD products	(4*fy_low – fx_high)	(4*fy_high – fx_low)	4*fx_low – fy_high	4*fx_high – fy_low
IMD frequency limits (MHz)	3038	3572	8467	9328
Two-tone 5 th order IMD products	(3* fy_low- 2*fx_high)	(3*fy_high- 2*fx_low)	2*fy_low – 3*fx_high	2*fy_high – 3*fx_low
IMD frequency limits (MHz)	1084	441	5206	4454
Two-tone 5 th order IMD products	(4*fy_low + fx_low)	(4*fy_high +fx_high)	(4*fx_low + fy_low)	(4*fx_high + fy_high)
IMD frequency limits (MHz)	8224	8758	11416	12277
Two-tone 5 th order IMD products	(3*fy_low + 2*fx_low)	(3*fy_high +2*fx_high)	(3*fx_low +2*fy_low)	(3*fx_high + 2*fy_high)
IMD frequency limits (MHz)	9288	9931	10352	11104

Based on the table 6.17.2.1-1:

- 2nd order harmonic products may also fall into Rx frequencies of bands 46, n79
- 3rd order harmonic products may also fall into Rx frequencies of band n79
- 2nd IMD products may also fall into Rx frequencies of band n77
- 3rd IMD products may also fall into Rx frequencies of bands 7/n7, 11, 21, 22, 24, 31, 32, 38/n38, 41/n41, 42, 43, 45, 46, 50/n50, 51/n51, 69, 72, 74/n74, 75/n75, 76/n76, n77, n78
- 4th IMD products may also fall into Rx frequencies of bands 2/n2, 3/n3, 9, 25/n25, 33, 34/n34, 35, 36, 37, 39/n39, 70/n70,
- 5th IMD products may also fall into Rx frequencies of bands 22, 42, 46, n77, n78

Table 6.17.2.1-2 lists the protected bands required for the 2UL bands CA configuration

Table 6.17.2.1-2: Protected bands for the 2UL bands CA configuration

E-UTRA and NR DC Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n41A-n50A	E-UTRA Band 1, 2, 3, 4, 5, 8, 10, 12, 13, 14, 17, 20, 24, 25, 26, 27, 28, 29, 30, 31, 34, 38, 39, 40, 42, 43, 44, 45, 48, 52, 65, 66, 67, 68, 70, 71, 73, 85 NR Band 1n, 2n, n3, n5, n8, n12, n20, n25, n28, n34, n38, n39, n40, n65, n66, n70, n71, n77, n78	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 9, 18, 19	F_{DL_low}	-	F_{DL_high}	-50	1
	NR Band n79	F_{DL_low}	-	F_{DL_high}	-50	1
	Frequency range	1884.5		1915.7	-41	0.3
NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2\text{MHz} + N \times \text{LCRB} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.						
NOTE 8: Applicable when co-existence with PHS system operating in 1884.5 -1915.7MHz.						
NOTE 30: This requirement applies when the NR carrier is confined within 2545-2575MHz or 2595-2645MHz and the channel bandwidth is between 10 to 50 MHz						

6.17.2.2 REFSENS requirements

As the TDD network is synchronized between band n41 and band n50 (UL at the same time and DL at the same time), As IMD is not an issue for TDD bands combination, there is no MSD issue for this combination.

6.18 CA_n41-n71

6.18.1 Common for 1 band UL and 2 bands UL CA

6.18.1.1 Operating bands for CA

Table 6.18.1.1-1: CA band combination of band n41+n71

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
	BS receive / UE transmit		BS transmit / UE receive			
	$F_{UL_low} - F_{UL_high}$		$F_{DL_low} - F_{DL_high}$			
n41	2469 MHz	-	2690 MHz	2469 MHz	TDD	
n71	663 MHz	-	698 MHz	617 MHz	FDD	

6.18.1.2 Channel bandwidths per operating band for CA

Table 6.18.1.2-1: Supported bandwidths per CA band combination of band nX+nY

NR CA configuration	NR Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Bandwidth combination set
CA_n41A-n71A	CA_n41A-n71A	n41	15		Yes	Yes	Yes			Yes	Yes					0
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
		n71	15	Yes	Yes	Yes	Yes									
			30		Yes	Yes	Yes									
			60													
	CA_n41A-n71B	n41	15		Yes	Yes	Yes		Yes	Yes	Yes					0
			30		Yes	Yes	Yes		Yes							
			60		Yes	Yes	Yes		Yes							
		n71	See CA_n71B Bandwidth Combination Set 0 in 38.101-1 Table 5.5A.1-1													
CA_n41C-n71A	-	n41	See CA_n41C BCS0 in RP-182256 "Revised WID on Rel-16 NR intra band Carrier Aggregation for xCC DL/yCC UL including contiguous and non-contiguous spectrum (x>=y)"													0
			15	Yes	Yes	Yes	Yes	Yes								
		n71	30		Yes	Yes	Yes	Yes								
			60													
CA_n41(2A)-n71A	-	n41	See CA_n41(2A) new BCS1 in revised WID "NR intra band CA for xCC DL/yCC UL including contiguous and non-contiguous spectrum"													0
			15	Yes	Yes	Yes	Yes	Yes								
		n71	30		Yes	Yes	Yes	Yes								
			60													
CA_n41(2A)-n71B	-	n41	See CA_n41(2A) Bandwidth Combination Set 1 in 38.101-1 Table 5.5A.2-1													0
		n71	See CA_n71B Bandwidth Combination Set 0 in 38.101-1 Table 5.5A.1-1													0
CA_n41C-n71B	-	n41	See CA_n41C Bandwidth Combination Set 0 in 38.101-1 Table 5.5A.1-1													0
		n71	See CA_n71B Bandwidth Combination Set 0 in 38.101-1 Table 5.5A.1-1													0

6.18.1.3 UE co-existence studies

Table 6.18.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA _ n41X-n71Y.

Table 6.18.1.3-1: Impact of UL/DL Harmonic

					2 nd Harmonic		3 rd Harmonic		4 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n41	2496	2690	2496	2690	4992	5380	7488	8070	9984	10760
n71	663	698	617	652	1326	1396	1989	2094	2652	2792

Band n71 uplink 4th harmonic hits band n41 downlink.

Table 6.18.1.3-2: Impact of UL/DL Harmonic mixing

					2 nd Harmonic		3 rd Harmonic		4 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n41	2496	2690	2496	2690	4992	5380	7488	8070	9984	10760
n71	663	698	617	652	1234	1304	1851	1956	2468	2608

Band n41 is at 4th receiver harmonic of band n71 no MSD is necessary.

6.18.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n41-n71, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values for low high combination are given in the tables below.

Table 6.18.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n41-n71	n41	0.3
	n71	0.6

Table 6.18.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n41-n71	n41	0
	n71	0.2

6.18.1.5 REFSENS requirements

MSD values are copied from CA_n8-n78 as it has also 4th harmonic relation.

Table 6.18.1.5-1: Reference sensitivity exceptions due to UL harmonic for NR CA FR1

MSD due to harmonic exception for the DL band													
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
		dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
n71	n41 ^{4,5}		10.8	9.1	8.0			5.1	4.2	3.5	2.3	2.1	1.4

bandwidths configured in the aggressor (lower) and victim (higher) bands in MHz, respectively.

NOTE 4: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of a low band for which the 4th transmitter harmonic is within the downlink transmission bandwidth of a high band.

NOTE 5: The requirements should be verified for UL NR-ARFCN of a low band (superscript LB) such that

$$f_{UL}^{LB} = \left\lfloor f_{DL}^{HB} / 0.4 \right\rfloor 0.1 \text{ in MHz and } F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2 \text{ with } f_{DL}^{HB} \text{ the carrier frequency of a high band in MHz and } BW_{Channel}^{LB} \text{ the channel bandwidth configured in the low band.}$$

Table 6.3A.4-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for NR CA, FR1

NR Band / Channel bandwidth of the high band													
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n71	n41		16	25	25			25	25	25	25	25	25

6.18.2 Specific for 2 bands UL CA

6.18.2.1 UE co-existence studies

Table 6.18.2.1-1 lists Band n41 + Band n71 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.18.2.1-1: Band n41 and Band n71 UL IMD products

UE UL carriers	fx_low	fx_high	<bfy_low< b=""></bfy_low<>	fy_high
2nd order IMD products	$ fy_{high} - fx_{low} $	$ fy_{low} - fx_{high} $	$ fy_{low} + fx_{low} $	$ fy_{high} + fx_{high} $
IMD frequency limits (MHz)	2027	1798	3159	3388
3rd order IMD products	$ fy_{high} - 2*fx_{low} $	$ fy_{low} - 2*fx_{high} $	$ 2*fy_{low} - fx_{high} $	$ 2*fy_{high} - fx_{low} $
IMD frequency limits (MHz)	1364	1100	4294	4717
3rd order IMD products	$ 2*fx_{low} + fy_{low} $	$ 2*fx_{high} + fy_{high} $	$ 2*fy_{low} + fx_{low} $	$ 2*fy_{high} + fx_{high} $
IMD frequency limits (MHz)	3822	4086	5655	6078
Two-tone 4th order IMD products	$ 2*fx_{low} - 2*fy_{high} $	$ 2*fx_{high} - 2*fy_{low} $	$ 2*fx_{low} + 2*fy_{low} $	$ 2*fx_{high} + 2*fy_{high} $
IMD frequency limits (MHz)	4054	3596	6318	6776
Two-tone 4th order IMD products	$ 3*fx_{low} - 1*fy_{high} $	$ 3*fx_{high} - 1*fy_{low} $	$ 3*fy_{low} - 1*fx_{high} $	$ 3*fy_{high} - 1*fx_{low} $
IMD frequency limits (MHz)	701	402	6790	7407
Two-tone 4th order IMD products	$ 3*fx_{low} + 1*fy_{low} $	$ 3*fx_{high} + 1*fy_{high} $	$ 3*fy_{low} + 1*fx_{low} $	$ 3*fy_{high} + 1*fx_{high} $
IMD frequency limits (MHz)	4485	4784	8151	8768
Two-tone 5th order IMD products	$ fx_{low} - 4*fy_{high} $	$ fx_{high} - 4*fy_{low} $	$ fy_{low} - 4*fx_{high} $	$ fy_{high} - 4*fx_{low} $
IMD frequency limits (MHz)	10097	9286	296	38
Two-tone 5th order IMD products	$ fx_{low} + 4*fy_{low} $	$ fx_{high} + 4*fy_{high} $	$ fy_{low} + 4*fx_{low} $	$ fy_{high} + 4*fx_{high} $
IMD frequency limits (MHz)	10647	11458	5148	5482
Two-tone 5th order IMD products	$ 2*fx_{low} - 3*fy_{high} $	$ 2*fx_{high} - 3*fy_{low} $	$ 2*fy_{low} - 3*fx_{high} $	$ 2*fy_{high} - 3*fx_{low} $
IMD frequency limits (MHz)	6744	6092	2898	3391
Two-tone 5th order IMD products	$ 2*fx_{low} + 3*fy_{low} $	$ 2*fx_{high} + 3*fy_{high} $	$ 2*fy_{low} + 3*fx_{low} $	$ 2*fy_{high} + 3*fx_{high} $
IMD frequency limits (MHz)	8814	9466	6981	7474

Based on Table 6.18.2.1-1 there are IMD4 issues affecting own Rx frequencies of band n71.

Table 6.18.2.1-2 lists the protected bands required for the 2UL bands CA configuration as to be used in Table 6.5A.3.2.3-1 of TS 38.101-1.

Table 6.18.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n41-n71	E-UTRA Band 4, 5, 12, 13, 14, 17, 24, 26, 30, 48, 66, 85	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 2, 25, 70	F_{DL_low}	-	F_{DL_high}	-50	1
	NR Band n71	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 29	F_{DL_low}	-	F_{DL_high}	-38	1
NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2 \text{ MHz} + N \times L_{CRB} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.						
NOTE 4: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.						

6.18.2.2 REFSENS requirements

Based on the co-existence studies for CA_n41-n71, MSD need to be defined. MSD value reused from DC_71A_n38A in table below and proposed to be included in TS 38.101-1.

Table 7.3A.5-1: 2DL/2UL interband Reference sensitivity QPSK $P_{REFSENS}$ and uplink/downlink configurations

Band / Channel bandwidth / N_{RB} / Duplex mode							
NR CA Configuration	NR Band	UL F_c (MHz)	UL/DL BW (MHz)	UL L_{CRB}	DL F_c (MHz)	MSD (dB)	IMD order
CA_n41A-n71A	n41	2614	5	25	2614	N/A	N/A
	h71	665	5	25	619	11	IMD4

6.19 CA_n3-n8

6.19.1 Common for 1 band UL and 2 bands UL CA

6.19.1.1 Operating bands for CA

Table 6.19.1.1-1: CA band combination of band n3+n8

NR CA Band	NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
		BS receive / UE transmit		BS transmit / UE receive			
		F_{UL_low} – F_{UL_high}	F_{DL_low} – F_{DL_high}	F_{DL_low} – F_{DL_high}	F_{DL_low} – F_{DL_high}		
CA_n3-n8	n3	1710 MHz – 1785 MHz	1805 MHz – 1880 MHz	1805 MHz – 1880 MHz	1805 MHz – 1880 MHz	FDD	
	n8	880 MHz – 915 MHz	925 MHz – 960 MHz	925 MHz – 960 MHz	925 MHz – 960 MHz	FDD	

6.19.1.2 Channel bandwidths per operating band for CA

Table 6.19.2-1: Supported bandwidths per CA band combination of band n3+n8

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n3A-n8A	CA_n3A-n8A	n3	15	Ye s	Ye s	Ye s	Ye s	Ye s	Ye s							0
			30		Ye s	Ye s	Ye s	Ye s	Ye s							
			60		Ye s	Ye s	Ye s	Ye s	Ye s							
		n8	15	Ye s	Ye s	Ye s	Ye s									
			30		Ye s	Ye s	Ye s									
			60													

6.19.1.3 Co-existence studies

Table 6.19.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n3-n8.

Table 6.19.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		nth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n3	1710	1785	1805	1880	3420	3570	5130	5355		
n8	880	915	925	960	1760	1830	2640	2745		

Based on above table, 2nd harmonic produce of band n8 may fall into band n3.

Table 6.19.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic			3rd Harmonic			nth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n3	1710	1785	1805	1880	3610	3760	5415	5640				
n8	880	915	925	960	1850	1920	2775	2880				

Based on above table, there is no harmonic mixing issue for the band combination of n3 and n8.

6.19.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n3-n8, the $T_{IB,c}$ and R_{IB} values are given in the tables below.

Table 6.19.1.4-1: $\Delta T_{IB,c}$

NR CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n3-n8	n3	0.3
	n8	0.3

Table 6.19.1.4-2: ΔR_{IB}

NR CA Configuration	NR Band	ΔR_{IB} [dB]
CA_n3-n8	n3	0
	n8	0

6.19.1.5 REFSENS requirements

Based on the co-existence study in Table 6.19.1.3-1, the 2nd harmonic produce of band n8 may fall into band n3. For the MSD caused by 2nd harmonic, it is quite similar with the LTE band 3 + band 8 CA combination. According to the analysis in R4-124625, the level of desense can be 17 dB in the case of 2nd harmonic interference for LTE band 3 and band 8 combination. However, the 2nd harmonic interference is much more likely that the interference does not exist at all for the particular spectrum holdings of the operator, or is avoidable by spectrum management or by network scheduling. Otherwise, When it is present, 2nd harmonic interference (~17dB MSD) severely degrades the link budget to a point that the connection may not be able to be maintained according to the analysis in R4-124625. Consequently, it is recommended not to define the test case for MSD caused by 2nd harmonic interference in the LTE Band 3 and Band 8 combination.

Thus, for NR band n3+ NR Band n8 CA band combination, same principle is recommended, which is not to define the test case for MSD caused by 2nd harmonic interference for this NR band combination, shown in table 6.19.1.5-1 to align with the format of NR spec.

Table 6.19.1.5-1 : MSD due to harmonic issue

MSD due to harmonic exception for the DL band													
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
		dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
n8	n3 ¹¹	N/A	N/A	N/A	N/A	N/A	N/A						

NOTE 11: No requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the low band for which the 2nd transmitter harmonic is within the downlink transmission bandwidth of the high band. The reference sensitivity for all active downlink component carriers is only verified when this is not the case (the requirements specified in clause 7.3.2 in TS38.101-1 apply unless otherwise specified).

6.19.2 Specific for 2 bands UL CA

6.19.2.1 UE co-existence studies

Table 6.19.2.1-1 lists Band n3 +Band n8 2UL CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.19.2.1-1: Band n3 and Band n8 UL IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency	880	915	1710	1785
2 nd order IMD products	fy_low-fx_high	fy_high-fx_low	fy_low+fx_low	fy_high+fx_high
IMD frequency limits (MHz)	795	905	2590	2700
Two-tone 3 rd order IMD products	fy_high - 2*fx_low	fy_low - 2*fx_high	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	0	120	2505	2690
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	3470	3615	4300	4485
Two-tone 3 rd order IMD products	(fx_low - max BW fy)	(fx_high + max BW fy)	(fy_low - max BW fx)	(fy_high + max BW fx)

IMD frequency limits (MHz)	860	935	1675	1820
Two-tone 4th order IMD products	$ 2*fx_low - 2* fy_high $	$ 2*fx_high - 2*fy_low $		
IMD frequency limits (MHz)	1810	1590		
Two-tone 4th order IMD products	$ 3*fx_low - 1* fy_high $	$ 3*fx_high - 1*fy_low $	$ 3*fy_low - 1*fx_high $	$ 3*fy_high - 1*fx_low $
IMD frequency limits (MHz)	855	1035	4215	4475
Two-tone 4th order IMD products	$ 2*fx_low + 2* fy_low $	$ 2*fx_high + 2* fy_high $		
IMD frequency limits (MHz)	5180	5400		
Two-tone 4th order IMD products	$ 3*fx_low + 1* fy_low $	$ 3*fx_high + 1* fy_high $	$ 3*fy_low + 1*fx_low $	$ 3*fy_high + 1*fx_high $
IMD frequency limits (MHz)	4350	4530	6010	6235
Two-tone 5th order IMD products	$ fx_low - 4*fy_high $	$ fx_high - 4*fy_low $	$ fy_low - 4*fx_high $	$ fy_high - 4*fx_low $
IMD frequency limits (MHz)	6260	5925	1950	1735
Two-tone 5th order IMD products	$ fx_low + 4*fy_low $	$ fx_high + 4*fy_high $	$ fy_low + 4*fx_low $	$ fy_high + 4*fx_high $
IMD frequency limits (MHz)	7720	8055	5230	5445
Two-tone 5th order IMD products	$ 2*fx_low - 3*fy_high $	$ 2*fx_high - 3*fy_low $	$ 2*fy_low - 3*fx_high $	$ 2*fy_high - 3*fx_low $
IMD frequency limits (MHz)	3595	3300	675	930
Two-tone 5th order IMD products	$ 2*fx_low + 3*fy_low $	$ 2*fx_high + 3*fy_high $	$ 2*fy_low + 3*fx_low $	$ 2*fy_high + 3*fx_high $
IMD frequency limits (MHz)	6890	7185	6060	6315
NOTE : For each IMD item, when two bound values before taking absolute have different signs, the relevant IMD range shall be set such that (1) the lower bound is 0 and (2) the upper bound is the bigger value of the two after taking absolute.				

Based on Table 6.19.2.1-1:

- Considering the maximum channel bandwidth supported for each bands, the 3rd order IMD may fall into Rx frequencies of both band n8 and band n3.
- 4th order IMD may fall into Rx frequencies of band n3.
- 5th order IMD may fall into Rx frequencies of both band n8 and band n3.

Table 6.19.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.19.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n3A-n8A	E-UTRA Band 1, 20, 28, 31, 32, 33, 34, 38, 39, 40, 44, 50, 51, 65, 67, 72, 73, 74, 75, 76	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA band 3, 8	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	RB restriction and centre frequency range restriction
	E-UTRA band 7, 22, 41, 42, 43, 52	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	860	-	890	-40	1	RB restriction and centre frequency range restriction
	NR Band n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception

6.19.2.2 REFSENS requirements

According to the co-existent analysis in table 6.19.2.1-1, although 3rd order IMD frequency range from “fx_low – max BW fy” to “fx_low + max BW fy” may fall into own Rx of both band n3 and band n8, MSD caused by this IM3 should not be specified due to lower PSD of NR transmission.

Table 6.19.2.2-1 lists the IMD4 and IMD5 MSD required for this CA configuration with dual uplink carrier.

Table 6.19.2.2-1: MSD due to IMD4 and IMD5 issue

Operating band / Channel bandwidth / N _{RB} / Duplex mode								Source of IMD
CA Configuration	Operating band	UL F _c (MHz)	UL/DL BW (MHz)	UL C _{LRB}	DL F _c (MHz)	MSD (dB)	Duplex mode	
CA_n3A-n8A	n3	1755	10	50	1850	N/A	FDD	N/A
	n8	900	5	25	945	8	FDD	IMD4 ⁴
CA_n3A-n8A	n3	1747.5	10	50	1842.5	6.4	FDD	IMD5
	n8	897.5	5	25	942.5	N/A	FDD	N/A

NOTE 1: 15 kHz SCS is assumed.
 NOTE 4: This band is subject to IMD5 also which MSD is not specified.

6.20 CA_n8-n79

6.20.1 Common for 1 band UL and 2 bands UL CA

6.20.1.1 Operating bands for CA

Table 6.20.1.1-1: CA band combination of band n8+n79

NR CA Band	NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
		BS receive / UE transmit		BS transmit / UE receive			
		$F_{UL_low} - F_{UL_high}$	$F_{DL_low} - F_{DL_high}$	$F_{DL_low} - F_{DL_high}$	$F_{DL_low} - F_{DL_high}$		
CA_n8-n79	n8	880 MHz – 915 MHz	925 MHz – 960 MHz	925 MHz – 960 MHz	925 MHz – 960 MHz	FDD	
	n79	4400 MHz – 5000 MHz	TDD				

6.20.1.2 Channel bandwidths per operating band for CA

Table 6.20.2-1: Supported bandwidths per CA band combination of band n8+n79

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n8A-n79A	CA_n8A-n79A	n8	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60													
		n79	15							Yes	Yes					
			30							Yes	Yes	Yes	Yes	Yes		
			60							Yes	Yes	Yes	Yes	Yes	Yes	

6.20.1.3 Co-existence studies

The studies for 1 band UL for the CA band combination of band n8 + n79 have been already completed in rel-15 and captured into TR 37.865-01-01. According to the study results in TR 37.865-01-01, the 5th order harmonic of Band n8 may fall into Rx frequencies of bands n79 causing de-sensing .

6.20.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n8-n79, the $T_{IB,c}$ and R_{IB} values are already specified in TR37.865-01-01.

6.20.1.5 REFSENS requirements

For single uplink operation of this combination, only harmonic issue need to be considered. The studies for 1 band UL for the CA band combination of band n8 + n79 have been already completed and the MSD values for Band n79 due to 5th harmonic of Band n8 in CA_n8A-n79A are captured into TR 37.865-01-01.

6.20.2 Specific for 2 bands UL CA

6.20.2.1 UE co-existence studies

Table 6.20.2.1-1 lists Band n8 +Band n79 2UL CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.20.2.1-1: Band n8 and Band n79 UL IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency	880	915	4400	5000
2 nd order IMD products	fy_low-fx_high	fy_high-fx_low	fy_low+fx_low	fy_high+fx_high
IMD frequency limits (MHz)	3485	4120	5280	5915
Two-tone 3 rd order IMD products	fy_high - 2*fx_low	fy_low - 2*fx_high	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	3240	2570	7885	9120
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	6160	6830	9680	10915
Two-tone 3 rd order IMD products	(fx_low - max BW fy)	(fx_high + max BW fy)	(fy_low - max BW fx)	(fy_high + max BW fx)
IMD frequency limits (MHz)	780	1015	4390	5010

Two-tone 4th order IMD products	$ 2*fx_low - 2*fy_high $	$ 2*fx_high - 2*fy_low $		
IMD frequency limits (MHz)	8240	6970		
Two-tone 4th order IMD products	$ 3*fx_low - 1*fy_high $	$ 3*fx_high - 1*fy_low $	$ 3*fy_low - 1*fx_high $	$ 3*fy_high - 1*fx_low $
IMD frequency limits (MHz)	2360	1655	12285	14120
Two-tone 4th order IMD products	$ 2*fx_low + 2*fy_low $	$ 2*fx_high + 2*fy_high $		
IMD frequency limits (MHz)	10560	11830		
Two-tone 4th order IMD products	$ 3*fx_low + 1*fy_low $	$ 3*fx_high + 1*fy_high $	$ 3*fy_low + 1*fx_low $	$ 3*fy_high + 1*fx_high $
IMD frequency limits (MHz)	7040	7745	14080	15880
Two-tone 5th order IMD products	$ fx_low - 4*fy_high $	$ fx_high - 4*fy_low $	$ fy_low - 4*fx_high $	$ fy_high - 4*fx_low $
IMD frequency limits (MHz)	19120	16685	740	1480
Two-tone 5th order IMD products	$ fx_low + 4*fy_low $	$ fx_high + 4*fy_high $	$ fy_low + 4*fx_low $	$ fy_high + 4*fx_high $
IMD frequency limits (MHz)	18480	20915	7920	8660
Two-tone 5th order IMD products	$ 2*fx_low - 3*fy_high $	$ 2*fx_high - 3*fy_low $	$ 2*fy_low - 3*fx_high $	$ 2*fy_high - 3*fx_low $
IMD frequency limits (MHz)	13240	11370	6055	7360
Two-tone 5th order IMD products	$ 2*fx_low + 3*fy_low $	$ 2*fx_high + 3*fy_high $	$ 2*fy_low + 3*fx_low $	$ 2*fy_high + 3*fx_high $
IMD frequency limits (MHz)	14960	16830	11440	12745
NOTE : For each IMD item, when two bound values before taking absolute have different signs, the relevant IMD range shall be set such that (1) the lower bound is 0 and (2) the upper bound is the bigger value of the two after taking absolute.				

Based on Table 6.20.2.1-1:

- 3rd order IMD may fall into Rx frequencies of band n79. However, since band n79 is TDD band, i.e. transmit and receive are not supported simultaneously in a single TDD band, which mean the IMD3 has no impact on the own band of n79. In addition, considering the maximum channel bandwidth supported in band n79, the 3rd order IMD may also fall into Rx frequencies of band n8.
 - 5th order IMD may fall into Rx frequencies of band n8.

Table 6.20.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.20.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n8A-n79A	E-UTRA Band 1, 8, 28, 34, 39, 40, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 3,41,42	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	RB restriction and centre frequency range restriction
	Frequency range	860	-	890	-40	1	RB restriction and centre frequency range restriction
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS

6.20.2.2 REFSENS requirements

According to the co-existent analysis in table 6.20.2.1-1, although 3rd order IMD frequency range from “fx_low – max BW fy” to “fx_low + max BW fy” may fall into own Rx of band n8, MSD caused by this IM3 should not be specified due to lower PSD of NR transmission.

Table 6.20.2.2-1 lists the IM5 MSD required for this CA configuration with dual uplink carrier.

Table 6.20.2.2-1: MSD due to IMD5 issue

Operating band / Channel bandwidth / N _{RB} / Duplex mode								Source of IMD
DC Configuration	Operating band	UL F _c (MHz)	UL/DL BW (MHz)	UL C _{LRB}	DL F _c (MHz)	MSD (dB)	Duplex mode	
CA_n8A-n79A	8	897.5	5	25	942.5	4.8	FDD	IMD5
	n79	4532.5	40	216	4532.5	N/A	TDD	N/A

NOTE 1: RB_{START} = 0
 NOTE 2: 15 kHz SCS is assumed.

6.21 CA_n25-n41

6.21.1 Common for 1 band UL and 2 bands UL CA

6.21.1.1 Operating bands for CA

Table 6.21.1.1-1: CA band combination of band nX+nY

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode		
	BS receive / UE transmit		BS transmit / UE receive				
	F _{UL_low} – F _{UL_high}		F _{DL_low} – F _{DL_high}				
n25	1850 MHz	–	1915 MHz	1930 MHz	–	1995 MHz	FDD
n41	2496 MHz	–	2690 MHz	2496 MHz	–	2690 MHz	TDD

6.21.1.2 Channel bandwidths per operating band for CA

Table 6.21.1.2-1: Supported bandwidths per CA band combination of band n25 and n41

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Band width combination set		
n25A-n41A	n25A-n41A	n25	15	Yes	Yes	Yes	Yes									0		
			30		Yes	Yes	Yes											
			60		Yes	Yes	Yes											
	n25(2A)-n41A	n41	15		Yes	Yes	Yes		Yes	Yes	Yes					0		
			30		Yes	Yes	Yes		Yes									
			60		Yes	Yes	Yes		Yes									
n25A-n41C	n25A-n41A	n25	n25	See CA_n25(2A) in table 5.5A.2-1 of TS 38.101-1													0	
			15		Yes	Yes	Yes		Yes	Yes	Yes							
			30		Yes	Yes	Yes		Yes									
	n41	n41	60		Yes	Yes	Yes		Yes	0								
			15	Yes	Yes	Yes	Yes											
n25A-n41(2A)	n25A-n41A	n25	30		Yes	Yes	Yes									0		
			60		Yes	Yes	Yes											
			n41	See CA_n41C in table 5.5A.1-1 of TS 38.101-1														
	n25(2A)-n41(2A)	n25A-n41A	15	Yes	Yes	Yes	Yes									0		
			30		Yes	Yes	Yes											
			60		Yes	Yes	Yes											
	n41	See CA_n41(2A) BCS1 in table 5.5A.2-1 of TS 38.101-1																

6.21.1.3 UE co-existence studies

Table 6.21.1.3-1 lists up to 7th harmonics for n25A-n41A.

Table 6.21.1.3-1: Impact of UL/DL Harmonic

			2 nd Harmonic		3 rd Harmonic		4 th Harmonic		5 th Harmonic		6 th Harmonic		7 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n25	1850	1915	3700	3830	5550	5745	7400	7660	9250	9575	11100	11490	12950	13405
n41	2496	2690	4992	5380	7488	8070	9984	10760	12480	13450	14976	16140	17472	18830

6.21.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n25A-n41, the $T_{IB,c}$ and $R_{IB,c}$ values are same as DC_25_n41 as they are defined in [2].

Table 6.21.1.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
CA_n25-n41	25	0.5
	n41	0.4 ¹ 0.9 ²
NOTE 1: The requirement is applied for UE transmitting on the frequency range of 2545-2690MHz.		
NOTE 2: The requirement is applied for UE transmitting on the frequency range of 2496-2545MHz.		

Table 6.21.1.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
CA_n25-n41	25	0
	n41	0

6.21.1.5 REFSENS requirements

For these combinations, sensitivity degradation is allowed for a band if it is impacted by the UL of another band that is part of the same CA configuration due to cross band isolation issues. RAN4 studied the impact of cross band isolation between Band 25 and n41 for DC_25A_n41A in [2] and decided that the MSD would be 0.6 dB the B25 DL due to n41 UL, and no MSD for the n41 DL due to the B25 UL. Reference sensitivity exceptions are specified in Table 7.3A.4-3 with uplink configuration specified in Table 7.3A.4-3a.

Table 7.3A.4-3: MSD for the CA configuration for asynchronous operation and cross band isolation for CA

NR CA Configuration	NR UL band	NR DL band	Channel bandwidth of the affected DL band											
			5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	30 MHz (dB)	40 MHz (dB)	50 MHz (dB)	60 MHz (dB)	80 MHz (dB)	90 MHz (dB)	100 MHz (dB)
CA_n25A-n41A	n41	n25	0.6	0.6	0.6	0.6								

NOTE 1: The Band n41 requirements are modified by -0.5dB when carrier frequency of the assigned NR channel bandwidth is within 2515-2690 MHz.

Table 7.3A.4-3a: Uplink configuration for reference sensitivity exceptions due to cross band isolation for CA

NR Band / SCS / Channel bandwidth of the affected DL band														
UL band	DL band	SCS of UL band (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n41	n25	15	160	160	160	160								

6.21.2 Specific for 2 bands UL CA

6.21.2.1 UE co-existence studies

Table 6.21.2.1-1 lists Band n25 + Band n41 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.21.2.1-1: Band n25 and Band n41 UL IMD products

UE UL carriers	fx_low	fx_high	fy_high	
2 nd order IMD products	fy_low - fx_high	fy_high - fx_low	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)		840 – 581		2496 – 4605
Two-tone 3 rd order IMD products	2*fx_low - fy_high	2*fx_high - fy_low	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)		1010 – 1334		3077 – 3530
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)		6196 – 6520		6842 – 7295
Two-tone 3 rd order IMD products	fx_low - max BW fy	fx_high + max BW fy	fy_low - max BW fx	fy_high + max BW fx
IMD frequency limits (MHz)		1750 – 2015		2476 – 2710
Two-tone 4 th order IMD products	3*fx_low - 1*fy_high	3*fx_high - 1*fy_low	3*fy_low - 1*fx_high	3*fy_high - 1*fx_low
IMD frequency limits (MHz)		2860 – 3249		5573 – 6220
Two-tone 4 th order IMD products	2*fx_low - 2*fy_high	2*fx_high - 2*fy_low		
IMD frequency limits (MHz)		1680 – 1162		
Two-tone 4 th order IMD products	3*fx_low + 1*fy_low	3*fx_high + 1*fy_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high
IMD frequency limits (MHz)		8046 – 8435		9338 – 9985
Two-tone 4 th order IMD products	2*fx_low + 2*fy_low	2*fx_high + 2*fy_high		
IMD frequency limits (MHz)		8692 – 9210		
Two-tone 5 th order IMD products	fx_low - 4*fy_high	fx_high - 4*fy_low	fy_low - 4*fx_high	fy_high - 4*fx_low
IMD frequency limits (MHz)		8910 – 8069		5164 – 4710
Two-tone 5 th order IMD products	2*fx_low - 3*fy_high	2*fx_high - 3*fy_low	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)		4370 – 3658		753 – 170
Two-tone 5 th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
IMD frequency limits (MHz)		11834 – 12675		9896 – 10350
Two-tone 5 th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)		11188 – 11900		10542 – 11125
NOTE :	For each IMD item, when two bound values before taking absolute have different signs, the relevant IMD range shall be set such that (1) the lower bound is 0 and (2) the upper bound is the bigger value of the two after taking absolute.			

Based on Table 6.21.2.1-1, 3rd order IMD may also fall into Rx frequencies of bands 25.

Table 6.21.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.21.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n25A-n41A	E-UTRA Band 4, 5, 10, 12, 13, 14, 17, 24, 26, 27, 28, 29, 30, 42, 48, 66, 70, 71, 85	F _{DL_low}	-	F _{DL_high}	-50	1
	E-UTRA Band 2, 25		-		-50	1
NOTE 1: To simplify Table, E-UTRA band numbers are listed for bands which are specified only for E-UTRA operation or both E-UTRA and NR operation. NR band numbers are listed for bands which are specified only for NR operation.						
NOTE 2: These requirements also apply for the frequency ranges that are less than FOOB (MHz) in Table 6.6.3.1-1 and Table 6.6.3.1A-1 from the edge of the channel bandwidth.						

6.21.2.2 REFSENS requirements

According to the co-existent analysis in table 6.21.2.1-1, although 3rd order IMD frequency range from “fx_low – max BW fy” to “fx_low + max BW fy” may fall into own Rx of band n25, MSD caused by this IM3 should not be specified due to lower PSD of NR transmission. Thus, no IMD issues are expected for this CA configuration with dual uplink carrier.

6.22 CA_n25-n71

6.22.1 Common for 1 band UL and 2 bands UL CA

6.22.1.1 Operating bands for CA

Table 6.22.1.1-1: CA band combination of band n25 and n71

NR Band	Uplink (UL) band				Downlink (DL) band				Duplex mode			
	BS receive / UE transmit				BS transmit / UE receive							
	$F_{UL_low} - F_{UL_high}$				$F_{DL_low} - F_{DL_high}$							
n25	1850 MHz		–		1915 MHz		1930 MHz		–		1995 MHz	FDD
n71	663 MHz		–		698 MHz		617 MHz		–		652 MHz	FDD

6.22.1.2 Channel bandwidths per operating band for CA

Table 6.22.1.2-1: Supported bandwidths per CA band combination of band n25 and n71

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Bandwidth combination set
CA_n25 A-n71A	CA_n25 A-n71A	n25	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
	CA_n25 A-n71A	n71	15	Yes	Yes	Yes	Yes									
			30		Yes	Yes	Yes									
			60													

6.22.1.3 UE co-existence studies

Table 6.22.1.3-1 lists up to 7th harmonics for n25A-n71A. As can be seen, 3rd harmonic from n71 UL might fall into n25 DL.

Table 6.22.1.3-1: Impact of UL/DL Harmonic

			2 nd Harmonic		3 rd Harmonic		4 th Harmonic		5 th Harmonic		6 th Harmonic		7 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n25	1850	1915	3700	3830	5550	5745	7400	7660	9250	9575	11100	11490	12950	13405
n71	663	698	1326	1396	1989	2094	2652	2792	3315	3490	3978	4188	4641	4886

Table 6.22.1.3-2 list harmonic mixing issue for the 2DL bands CA with 1 UL. As can be seen, 3rd harmonic mixing from n71 DL might affect n25 UL.

Table 6.22.1.3-2 Harmonic mixing for 2DLs/1UL

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2 nd Harmonic		3 rd Harmonic		4 th Harmonic	
	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n25	1850	1915	1930	1995	3860	3990	5790	5985	7720	7980
n71	663	698	617	652	1234	1304	1851	1956	2468	2608

6.22.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n25A-n71, the $T_{IB,c}$ and $R_{IB,c}$ values are derived from LTE CA_4-17 which use a trap filter.

Table 6.22.1.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
CA_n25-n71	25	0.3
	n71	0.6

Table 6.22.1.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
CA_n25-n71	25	0
	n71	0.3

6.22.1.5 REFSENS requirements

Due to identified harmonic issues MSD is derived from CA_4-17 and need to be defined in 38.101-1 as defined below.

Table 7.3A.4-1: Reference sensitivity exceptions due to UL harmonic for NR CA FR1

MSD due to harmonic exception for the DL band													
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
		dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
n71	n25 ⁶	10	7.5	6	5.1								

NOTE 6: These requirements apply when the lower edge frequency of the 10 MHz, 15 MHz, or 20 MHz uplink channel in Band 71 is located at or below 668 MHz and the downlink channel in Band n25 is located with its upper edge at 1995 MHz.

NOTE 7: These requirements apply when there is at least one individual RE within the downlink transmission bandwidth of the victim (lower) band for which the 3rd harmonic is within the uplink transmission bandwidth or the uplink adjacent channel's transmission bandwidth of an aggressor (higher) band.

NOTE 8: The requirements should be verified for UL EARFCN of the aggressor (higher) band (superscript HB) such that $f_{DL}^{LB} = \lfloor f_{UL}^{HB} / 0.3 \rfloor 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{LB} the carrier frequency in the victim (lower) band and $BW_{Channel}^{HB}$ the channel bandwidth configured in the higher band.

Table 7.3A.4-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for NR CA, FR1

NR Band / Channel bandwidth of the high band													
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n71	n25	8 ³	8 ³	8 ³	8 ³								
NOTE 3: These requirements apply when the lower edge frequency of the uplink channel in Band n71 is located at or below 668 MHz and the downlink channel in Band n25 is located with its upper edge at 1995 MHz													

Table 7.3A.4-4: Reference sensitivity exceptions due to harmonic mixing for CA in NR FR1

NR Band / Channel bandwidth of the affected DL band													
UL band	DL band	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	40 MHz (dB)	50 MHz (dB)	60 MHz (dB)	80 MHz (dB)	90 MHz (dB)	100 MHz (dB)	
n25	n71 ^{3,4}	26.5	23.3	20.9	15.3								
NOTE 3: These requirements apply when there is at least one individual RE within the downlink transmission bandwidth of the victim (lower) band for which the 3 rd harmonic is within the uplink transmission bandwidth or the uplink adjacent channel's transmission bandwidth of an aggressor (higher) band.													
NOTE 4: The requirements should be verified for UL NR-ARFCN of the aggressor (higher) band (superscript HB) such that $f_{DL}^{LB} = \lfloor f_{UL}^{HB} / 0.3 \rfloor 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{LB} the carrier frequency in the victim (lower) band and $BW_{Channel}^{HB}$ the channel bandwidth configured in the higher band.													

Table 7.3A.4-4a: Uplink configuration for reference sensitivity exceptions due to receiver harmonic mixing for CA in NR FR1

NR Band / SCS / Channel bandwidth of the affected DL band													
UL band	DL band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n25	n71	15	25	50	75	100							
NOTE 1: The UL configuration applies regardless of the channel bandwidth of the UL band unless the UL resource blocks exceed that specified in Table 7.3.2-3 for the uplink bandwidth in which case the allocation according to Table 7.3.2-3 applies.													

6.22.2 Specific for 2 bands UL CA

6.22.2.1 UE co-existence studies

Table 6.22.2.1-1 lists Band n25 + Band n71 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.22.2.1-1: Band n25 and Band n71 UL IMD products

UE UL carriers	fx_low	fx_high	<bfy_low< b=""></bfy_low<>	fy_high
2nd order IMD products	$ fy_{high} - fx_{low} $	$ fy_{low} - fx_{high} $	$ fy_{low} + fx_{low} $	$ fy_{high} + fx_{high} $
IMD frequency limits (MHz)	1252	1152	2513	2613
3rd order IMD products	$ fy_{high} - 2*fx_{low} $	$ fy_{low} - 2*fx_{high} $	$ 2*fy_{low} - fx_{high} $	$ 2*fy_{high} - fx_{low} $
IMD frequency limits (MHz)	589	454	3002	3167
3rd order IMD products	$ 2*fx_{low} + fy_{low} $	$ 2*fx_{high} + fy_{high} $	$ 2*fy_{low} + fx_{low} $	$ 2*fy_{high} + fx_{high} $
IMD frequency limits (MHz)	3176	3311	4363	4528
Two-tone 4th order IMD products	$ 2*fx_{low} - 2*fy_{high} $	$ 2*fx_{high} - 2*fy_{low} $	$ 2*fx_{low} + 2*fy_{low} $	$ 2*fx_{high} + 2*fy_{high} $
IMD frequency limits (MHz)	2504	2304	5026	5226
Two-tone 4th order IMD products	$ 3*fx_{low} - 1*fy_{high} $	$ 3*fx_{high} - 1*fy_{low} $	$ 3*fy_{low} - 1*fx_{high} $	$ 3*fy_{high} - 1*fx_{low} $
IMD frequency limits (MHz)	74	244	4852	5082
Two-tone 4th order IMD products	$ 3*fx_{low} + 1*fy_{low} $	$ 3*fx_{high} + 1*fy_{high} $	$ 3*fy_{low} + 1*fx_{low} $	$ 3*fy_{high} + 1*fx_{high} $
IMD frequency limits (MHz)	3839	4009	6213	6443
Two-tone 5th order IMD products	$ fx_{low} - 4*fy_{high} $	$ fx_{high} - 4*fy_{low} $	$ fy_{low} - 4*fx_{high} $	$ fy_{high} - 4*fx_{low} $
IMD frequency limits (MHz)	6997	6702	942	737
Two-tone 5th order IMD products	$ fx_{low} + 4*fy_{low} $	$ fx_{high} + 4*fy_{high} $	$ fy_{low} + 4*fx_{low} $	$ fy_{high} + 4*fx_{high} $
IMD frequency limits (MHz)	8063	8358	4502	4707
Two-tone 5th order IMD products	$ 2*fx_{low} - 3*fy_{high} $	$ 2*fx_{high} - 3*fy_{low} $	$ 2*fy_{low} - 3*fx_{high} $	$ 2*fy_{high} - 3*fx_{low} $
IMD frequency limits (MHz)	4419	4154	1606	1841
Two-tone 5th order IMD products	$ 2*fx_{low} + 3*fy_{low} $	$ 2*fx_{high} + 3*fy_{high} $	$ 2*fy_{low} + 3*fx_{low} $	$ 2*fy_{high} + 3*fx_{high} $
IMD frequency limits (MHz)	6876	7141	5689	5924

Based on Table 6.22.2.1-1 there are no IMD issues affecting own Rx frequencies.

Table 6.22.2.1-2 lists the protected bands required for the 2UL bands CA configuration as to be used in Table 6.5A.3.2.3-1 of TS 38.101-1.

Table 6.22.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n25-n71	E-UTRA Band 4, 5, 12, 13, 14, 17, 24, 26, 30, 48, 53, 66, 85	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 41, 70	F_{DL_low}	-	F_{DL_high}	-50	1
	NR Band n71	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 29	F_{DL_low}	-	F_{DL_high}	-38	1
NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2 \text{ MHz} + N \times L_{CRB} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.						
NOTE 4: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.						

6.22.2.2 REFSENS requirements

Based on the co-existence studies for CA_n25-n71 there are no further MSD needed to be defined.

6.23 CA_n39-n79

6.23.1 Common for 1 band UL and 2 bands UL

6.23.1.1 Operating bands for CA

Table 6.23.1.1-1: CA band combination of band n39+n79

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode		
	BS receive / UE transmit		BS transmit / UE receive				
	$F_{UL_low} - F_{UL_high}$		$F_{DL_low} - F_{DL_high}$				
n39	1880 MHz	–	1920 MHz	1880 MHz	–	1920 MHz	TDD
n79	4400 MHz	–	5000 MHz	4400 MHz	–	5000 MHz	TDD

6.23.1.2 Channel bandwidths per operating band for CA

Table 6.23.1.2-1: Supported bandwidths per CA band combination of band n39+n79

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combinatio n set
CA_n39A-n79A	CA_n39A-n79A	n39	15	Yes						0						
			30		Yes	Yes	Yes	Yes	Yes	Yes						
			60		Yes	Yes	Yes	Yes	Yes	Yes						
		n79	15							Yes	Yes					
			30							Yes	Yes	Yes	Yes	Yes	Yes	
			60							Yes	Yes	Yes	Yes	Yes	Yes	

6.23.1.3 UE co-existence studies

Table 6.9.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n39-n79.

Table 6.23.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		4th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n39	1880	1920	1880	1920	3760	3840	5640	5760	7520	7680
n79	4400	5000	4400	5000	8800	10000	13200	15000	17600	20000

Based on above table, there is no harmonic issue for the band combination of Band n39 and Band n79.

Table 6.23.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic		3rd Harmonic		4 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n39	1880	1920	1880	1920	3760	3840	5640	5760	7520	7680
n79	4400	5000	4400	5000	8800	10000	13200	15000	17600	20000

Based on above table, there is no harmonic mixing issue for the band combination of n39 and n79.

6.23.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n39-n79 , the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 6.23.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n39-n79	n39	0.3
	n79	0.8

Table 6.23.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n39-n79	n39	0
	n79	0.5

6.23.1.5 REFSENS requirements

There is no MSD issue due to harmonic interference for this band combination.

6.23.2 Specific for 2 bands UL CA

6.23.2.1 UE co-existence studies

Table 6.23.2.1-1 gives IMD interference analysis for CA_n39-n79` with 2 ULs.

Table 6.23.2.1-1: Band n39 and Band n79 IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	1880	1920	4400	5000
2 nd order IMD products	fy_low - fx_high	fy_high - fx_low	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	2480-3120		6280-6920	
Two-tone 3 rd order IMD products	2*fx_low - fy_high	2*fx_high - fy_low	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	1240-560		6880-8120	
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	8160-8840		10680-11920	
Two-tone 3 rd order IMD products	(fx_low - max BW fy)	(fx_high + max BW fy)	(fy_low - max BW fx)	(fy_high + max BW fx)
IMD frequency limits (MHz)	1780-2020		4380-5020	
Two-tone 4 th order IMD products	3*fx_low - 1*fy_high	3*fx_high - 1*fy_low	3*fy_low - 1*fx_high	3*fy_high - 1*fx_low
IMD frequency limits (MHz)	640-1360		11280-13120	
Two-tone 4 th order IMD products	2*fx_low - 2*fy_high	2*fx_high - 2*fy_low		
IMD frequency limits (MHz)	6240-4960			
Two-tone 4 th order IMD products	3*fx_low + 1*fy_low	3*fx_high + 1*fy_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high
IMD frequency limits (MHz)	10040-10760		15080-16920	
Two-tone 4 th order IMD products	2*fx_low + 2*fy_low	2*fx_high + 2*fy_high		
IMD frequency limits (MHz)	12560-13840			
Two-tone 5 th order IMD products	fx_low - 4*fy_high	fx_high - 4*fy_low	fy_low - 4*fx_high	fy_high - 4*fx_low
IMD frequency limits (MHz)	18120-15680		3280-2520	
Two-tone 5 th order IMD products	2*fx_low - 3*fy_high	2*fx_high - 3*fy_low	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)	11240-9360		3040-4360	
Two-tone 5 th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
IMD frequency limits (MHz)	19480-21920		11920-12680	
Two-tone 5 th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	16960-18840		14440-15760	

Based on Table 6.23.2.1-1, the 3rd 4th order IMD product may fall into Band 39. However it should be noted that IMD will not be an issue for TDD bands combination (no self-interference for the TDD band) even through the IMD products may fall into the concerning band.

Table 6.23.2.1-2 lists the protected bands required for this CA configuration.

Table 6.23.2.1-2: Protected bands for CA_n39A-n79A

NR CA combination	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n39A-n79A	E-UTRA Band 1, 8, 34, 40, 41, 44, 45 or NR Band n1, n8, n34, n40, n41, n78	FDL_low	-	FDL_high	-50	1
	Frequency range	1805	-	1855	-40	1
	Frequency range	1855	-	1880	-15.5	5

6.23.2.2 REFSENS requirements

There is no MSD issue due to IMD interference for this band combination.

6.24 CA n40-n78

6.24.1 Common for 1 band UL and 2 bands UL CA

6.24.1.1 Operating bands for CA

Table 6.24.1.1-1: CA band combination of band n40 and n78

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
	BS receive / UE transmit		BS transmit / UE receive			
	F_{UL_low} – F_{UL_high}	F_{DL_low} – F_{DL_high}				
n40	2300 MHz – 2400 MHz	2300 MHz – 2400 MHz			TDD	
n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz				

6.24.1.2 Channel bandwidths per operating band for CA

Table 6.24.1.2-1: Supported bandwidths per CA band combination of band n40 and n78

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Band width combination set
n40A-n78A	n40A-n78A	n40	15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes					0
			30		Yes											
			60		Yes											
		n78	15		Yes	Yes	Yes			Yes	Yes					0
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
n40A-n78(2A)	n40A-n78A	n40	15	Yes	Yes	Yes	Yes	Yes	Yes	Yes						0
			30		Yes											
			60		Yes											
		n78														

6.24.1.3 UE co-existence studies

Table 6.24.1.3-1 lists up to 7th harmonics for n40A-n78A.

Table 6.24.1.3-1: Impact of UL/DL Harmonic

			2 nd Harmonic		3 rd Harmonic		4 th Harmonic		5 th Harmonic		6 th Harmonic		7 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n40	2300	2400	4600	4800	6900	7200	9200	9600	11500	12000	13800	14400	16100	16800
n78	3300	3800	6600	7600	9900	11400	13200	15200	16500	19000	19800	22800	23100	26600

Table 6.24.1.3-2 and Table 6.24.1.3-3 list harmonic mixing issue for the 2DL bands CA with 1 UL.

Table 6.24.1.3-2: Harmonic Interference for 2DLs/1UL

					2 nd Harmonic		3 rd Harmonic		4 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n40	2300	2400	2300	2400	4600	4800	6900	7200	9200	9600
n78	3300	3800	3300	3800	6600	7600	9900	11400	13200	15200

Table 6.24.1.3-3 Harmonic mixing for 2DLs/1UL

					2 nd Harmonic		3 rd Harmonic		4 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n40	2300	2400	2300	2400	4600	4800	6900	7200	9200	9600
n78	3300	3800	3300	3800	6600	7600	9900	11400	13200	15200

It can be seen that the frequency range of the 3rd harmonic of n40 UL/DL overlaps with that of the 2nd harmonic of n78 DL/UL. Hence there will be Rx desensing caused by receiver harmonic mixing for asynchronous operations.

6.24.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n40A-n78A or CA_n40A-n78(2A), the $T_{IB,c}$ and $R_{IB,c}$ values are derived from LTE combinations CA_40-42 and CA_40-43 and are given in the tables below.

Table 6.24.1.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
n40-n78	n40	0
	n78	0.5

Table 6.24.1.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
n40-n78	n40	0.4 ¹
	n78	0.5 ¹

6.24.1.5 REFSENS requirements

According to the co-existence study in Section 6.24.1.3, the DL performance may be affected by the receiver harmonic mixing during asynchronous operations. More explicitly, the 2nd harmonic of n78 UL may mix with the 3rd harmonic of n40 DL and cause degradation to n40 DL. Similarly, the 3rd harmonic of n40 UL may mix with the 2nd harmonic of n78 DL and cause degradation to n78 DL. The following MSD values are proposed to add to Table 7.3A.4-4 and Table 7.3A.4-5 in TS 38.101-1. The values are reused from CA_n41-n78.

Table 7.3A.4-4: Reference sensitivity exceptions due to harmonic mixing for CA in NR FR1

NR Band / Channel bandwidth of the affected DL band												
UL band	DL band	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	40 MHz (dB)	50 MHz (dB)	60 MHz (dB)	80 MHz (dB)	90 MHz (dB)	100 MHz (dB)
n40	n78 ¹		8.3	8.0	6.9		3.9	3	2.3	1.2		0.4
n78	n40 ²	10.4	10.4	10.4	10.4		7.2	6.2	5.5	4.5		

NOTE 1: The requirements should be verified for UL NR-ARFCN of the aggressor (lower) band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.15 \rfloor 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{HB} carrier frequency in the victim (higher) band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the lower band.

NOTE 2: The requirements should be verified for UL NR-ARFCN of the aggressor (high) band (superscript HB) such that $f_{UL}^{LB} = \lfloor 15 * f_{DL}^{HB} \rfloor 0.1$ in MHz and $F_{UL_low}^{HB} + BW_{Channel}^{HB} / 2 \leq f_{UL}^{HB} \leq F_{UL_high}^{HB} - BW_{Channel}^{HB} / 2$ with f_{DL}^{LB} carrier frequency in the victim (lower) band in MHz and $BW_{Channel}^{HB}$ the channel bandwidth configured in the higher band.

NOTE 3: These requirements apply when there is at least one individual RE within the downlink transmission bandwidth of the victim (lower) band for which the 3rd harmonic is within the uplink transmission bandwidth or the uplink adjacent channel's transmission bandwidth of an aggressor (higher) band.

NOTE 4: The requirements should be verified for UL NR-ARFCN of the aggressor (higher) band (superscript HB) such that $f_{DL}^{LB} = \lfloor f_{UL}^{HB} / 0.3 \rfloor 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{LB} the carrier frequency in the victim (lower) band and $BW_{Channel}^{HB}$ the channel bandwidth configured in the higher band.

Table 7.3A.4-4a: Uplink configuration for reference sensitivity exceptions due to receiver harmonic mixing for CA in NR FR1

NR Band / SCS / Channel bandwidth of the affected DL band													
UL band	DL band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n40	n78	30		24	24	24		24	24	24	24		24
n78	n40	30	50	50	50	50		50	50	50	50		

NOTE 1: The UL configuration applies regardless of the channel bandwidth of the UL band unless the UL resource blocks exceed that specified in Table 7.3.2-3 for the uplink bandwidth in which case the allocation according to Table 7.3.2-3 applies.

For asynchronous operations, the following MSD due to lack of cross band isolation is proposed to add to Table 7.3A.6-1 and Table 7.3A.6-2 in TS 38.101-1. The values are reused from CA_n41-n78.

Table 7.3A.6-1: MSD for the CA configuration for asynchronous operation and cross band isolation for CA

NR Band / Channel bandwidth of the affected DL band														
NR CA Configuration	UL band	DL band	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	30 MHz (dB)	40 MHz (dB)	50 MHz (dB)	60 MHz (dB)	80 MHz (dB)	90 MHz (dB)	100 MHz (dB)
CA_n40A-n78A CA_n40A-n78(2A)	n78	n40 ¹	4.5	4.5	4.5	4.5			4.5	4.5	4.5	4.5		
NOTE 1: Applicable only when harmonic mixing MSD for this combination is not applied.														
NOTE 2: Void														

Table 7.3A.6-2: Uplink configuration for reference sensitivity exceptions due to cross band isolation for CA

NR Band / SCS / Channel bandwidth of the affected DL band														
UL band	DL band	SCS of UL band (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n78	n40	30	270	270	270	270			270	270	270	270		
NOTE 1: The UL configuration applies regardless of the channel bandwidth of the UL band unless the UL resource blocks exceed that specified in Table 7.3.2-3 for the uplink bandwidth in which case the allocation according to Table 7.3.2-3 applies.														
NOTE 2: Refers to 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 in Table 5.3.2-1.														

6.24.2 Specific for 2 bands UL CA

6.24.2.1 UE co-existence studies

Table 6.24.2.1-1 lists Band n40 +Band n78 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.24.2.1-1: Band n40 and Band n78 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	2300	2400	3300	3800
2 nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2 nd harmonics frequency limits (MHz)	4600	4800	6600	7600
3 rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3 rd harmonics frequency limits (MHz)	6900	7200	9900	11400
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	9200	9600	13200	15200
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	11500	12000	16500	19000
2 nd order IMD products	fy_low - fx_high	fy_high - fx_low	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	900	1500	5600	6200
Two-tone 3 rd order IMD products	2*fx_low - fy_high	2*fx_high - fy_low	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	800	1500	4200	5300
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	7900	8600	8900	10000
Two-tone 4 th order IMD products	3*fx_low - 1*fy_high	3*fx_high - 1*fy_low	3*fy_low - 1*fx_high	3*fy_high - 1*fx_low
IMD frequency limits (MHz)	3100	3900	7500	9100

Two-tone 4 th order IMD products	$ 3*fx_low + 1*fy_low $	$ 3*fx_high + 1*fy_high $	$ 3*fy_low + 1*fx_low $	$ 3*fy_high + 1*fx_high $
IMD frequency limits (MHz)	10200	11000	12200	13800
Two-tone 4 th order IMD products	$ 2*fx_low - 2*fy_high $	$ 2*fx_high - 2*fy_low $	$ 2*fx_low + 2*fy_low $	$ 2*fx_high + 2*fy_high $
IMD frequency limits (MHz)	3000	1800	11200	12400
Two-tone 5 th order IMD products	$ fx_low - 4*fy_high $	$ fx_high - 4*fy_low $	$ fy_low - 4*fx_high $	$ fy_high - 4*fx_low $
IMD frequency limits (MHz)	12900	10800	6300	5400
Two-tone 5 th order IMD products	$ 2*fx_low - 3*fy_high $	$ 2*fx_high - 3*fy_low $	$ 2*fy_low - 3*fx_high $	$ 2*fy_high - 3*fx_low $
IMD frequency limits (MHz)	6800	5100	600	700

Since both bands are TDD, there is no MSD issue due to IMD for this band combination.

Table 6.24.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.24.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n40-n78	F-UTRA Band 1, 3, 5, 7, 8, 20, 22, 26, 27, 28, 31, 32, 33, 34, 38, 39, 41, 42, 44, 45, 50, 51, 52, 65, 67, 68, 69, 72, 73, 74, 75, 76	F_{DL_low}	-	F_{DL_high}	-50	1
	NR Band n79	F_{DL_low}	-	F_{DL_high}	-50	1
NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2\text{MHz} + N \times \text{LCRB} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.						

NOTE: All the tables mentioned in the note of above table are specified in TS38.101-1.

6.24.2.2 REFSENS requirements

There is no need for additional REFSENS requirements.

6.25 CA_n40-n79

6.25.1 Common for 1 band UL and 2 bands UL

6.25.1.1 Operating bands for CA

Table 6.25.1.1-1: CA band combination of band n40+n79

NR Band	Uplink (UL) band	Downlink (DL) band	Duplex mode
	BS receive / UE transmit	BS transmit / UE receive	
	$F_{UL_low} - F_{UL_high}$	$F_{DL_low} - F_{DL_high}$	

n40	2300 MHz – 2400 MHz	2300 MHz – 2400 MHz	TDD
n79	4400 MHz – 5000 MHz	4400 MHz – 5000 MHz	TDD
Note 1: Applicable for frequency range above 4800 MHz for Band n79 in this combination.			

6.25.1.2 Channel bandwidths per operating band for CA

Table 6.25.1.2-1: Supported bandwidths per CA band combination of band n40+n79

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n40A-n79A	CA_n40A-n79A	n40	15	Yes					0							
			30		Yes											
			60		Yes											
		n79	15							Yes	Yes					1
			30							Yes	Yes	Yes	Yes			
			60							Yes	Yes	Yes	Yes			
		n40	15	Yes						1						
			30		Yes	Yes	Yes	Yes	Yes	Yes						
			60		Yes	Yes	Yes	Yes	Yes	Yes						
		n79	15							Yes	Yes					
			30							Yes	Yes	Yes	Yes			
			60							Yes	Yes	Yes	Yes			

6.25.1.3 UE co-existence studies

Table 6.25.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n40-n79.

Table 6.25.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		nth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n40	2300	2400	2300	2400	4600	4800	6900	7200		
n79	4400	5000	4400	5000	8800	10000	13200	15000		

Based on above table, there is 2nd harmonic issue for the band combination of n40 and n79.

Table 6.25.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic		3rd Harmonic		mth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n40	2300	2400	2300	2400	4600	4800	6900	7200		
n79	4400	5000	4400	5000	8800	10000	13200	15000		

Based on above table, there may be 2nd harmonic mixing issue for the band combination of n40 and n79. However, there may be no MSD issue due to even order harmonic mixing according to the agreed WF R4-1709139 .

6.25.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n40-n79, the $T_{IB,c}$ and $R_{IB,c}$ values for UEs not supporting simultaneous Rx/Tx are given in the tables below.

Table 6.25.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n40-n79	n40	0.3
	n79	0.8

Table 6.25.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n40-n79	n40	0
	n79	0.5

6.25.1.5 REFSENS requirements

Regarding to the MSD due to 2nd harmonic of band 40 falling into n79, since this band combination will only be used in China where the frequency range above 4800 MHz for band n79 is allocated to IMT in China. So the 2nd harmonic issue will not be a problem for this combination.

6.25.2 Specific for 2 bands UL CA

6.25.2.1 UE co-existence studies

Table 6.25.2.1-1 lists Band n40 +Band n79 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.25.2.1-1: Band n40 and Band n79 2UL bands IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	2300	2400	4400	5000
2 nd order IMD products	fy_low - fx_high	fy_high - fx_low	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	2000 - 2700		6700 - 7400	
Two-tone 3 rd order IMD products	2*fx_low - fy_high	2*fx_high - fy_low	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	0 - 400		6400 - 7700	
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	9000 - 9800		11100 - 12400	
Two-tone 3 rd order IMD products	(fx_low - max BW fy)	(fx_high + max BW fy)	(fy_low - max BW fx)	(fy_high + max BW fx)
IMD frequency limits (MHz)	2200 - 2500		4320 - 5080	
Two-tone 4 th order IMD products	3*fx_low - 1*fy_high	3*fx_high - 1*fy_low	3*fy_low - 1*fx_high	3*fy_high - 1*fx_low
IMD frequency limits (MHz)	1900 - 2800		10800 - 12700	
Two-tone 4 th order IMD products	2*fx_low - 2*fy_high	2*fx_high - 2*fy_low		
IMD frequency limits (MHz)	4000 - 5400			
Two-tone 4 th order IMD products	3*fx_low + 1*fy_low	3*fx_high + 1*fy_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high
IMD frequency limits (MHz)	11300 - 12200		15500 - 17400	
Two-tone 4 th order IMD products	2*fx_low + 2*fy_low	2*fx_high + 2*fy_high		
IMD frequency limits (MHz)	13400 - 14800			
Two-tone 5 th order IMD products	fx_low - 4*fy_high	fx_high - 4*fy_low	fy_low - 4*fx_high	fy_high - 4*fx_low
IMD frequency limits (MHz)	15200 - 17700		4200 - 5200	
Two-tone 5 th order IMD products	2*fx_low - 3*fy_high	2*fx_high - 3*fy_low	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)	8400 - 10400		1600 - 3100	
Two-tone 5 th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
IMD frequency limits (MHz)	19900 - 22400		13600 - 14600	
Two-tone 5 th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	17800 - 19800		15700 - 17200	
NOTE :	For each IMD item, when two bound values before taking absolute have different signs, the relevant IMD range shall be set such that (1) the lower bound is 0 and (2) the upper bound is the bigger value of the two after taking absolute.			

As IMD is not an issue for TDD bands combination, there is no MSD issue for this band combination.

Table 6.25.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.25.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n40-n79	E-UTRA Band 1, 3, 5, 8, 28, 34, 39, 41, 42, 65,	F _{DL_low}	-	F _{DL_high}	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3
NOTE 3: Applicable when co-existence with PHS system operating in 1884.5 -1915.7MHz.						
NOTE x: This requirement applies when the NR carriers are confined within 2545-2575 MHz or 2595-2645 MHz and the channel bandwidth is 10 or 20 MHz						

NOTE: All the tables mentioned in the note of above table are specified in TS38.101-1.

6.25.2.2 REFSENS requirements

As IMD is not an issue for TDD bands combination, there is no MSD issue due to IMD for this combination.

6.26 CA_n8-n39

6.26.1 Common for 1 band UL and 2 bands UL

6.26.1.1 Operating bands for CA

Table 6.26.1.1-1: CA band combination of band n8+n39

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
	BS receive / UE transmit			BS transmit / UE receive				
	F_{UL_low} – F_{UL_high}	F_{DL_low} – F_{DL_high}						
n8	880 MHz	–	915 MHz	925 MHz	–	960 MHz	FDD	
n39	1880 MHz	–	1920 MHz	1880 MHz	–	1920 MHz	TDD	

6.26.1.2 Channel bandwidths per operating band for CA

Table 6.26.1.2-1: Supported bandwidths per CA band combination of band n8+n39

CA operating / channel bandwidth [MHz]																Bandwidth combination set
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	
CA_n8A-n39A	CA_n8A-n39A	n8	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60													
		n39	15	Yes												
			30		Yes											
			60		Yes											

6.26.1.3 UE co-existence studies

Table 6.26.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n8-n39.

Table 6.26.1.3-1: Impact of UL/DL Harmonic

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	2nd Harmonic			3rd Harmonic			nth Harmonic	
				DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge
n8	880	915	925	960	1760	1830	2640	2745			
n39	1880	1920	1880	1920	3760	3840	5640	5760			

Based on above table, there is no harmonic issue for the band combination of n8 and n39.

Table 6.26.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic		3rd Harmonic		mth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n8	880	915	925	960	1850	1920	2775	2880		
n39	1880	1920	1880	1920	3760	3840	5640	5760		

Based on above table, there may be no harmonic mixing issue for the band combination of n8 and n39.

6.26.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n8-n39, the $T_{IB,c}$ and $R_{IB,c}$ values for UEs not supporting simultaneous Rx/Tx are given in the tables below.

Table 6.26.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n8-n39	n8	0.3
	n39	0.3

Table 6.26.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n8-n39	n8	0
	n39	0

6.26.1.5 REFSENS requirements

There are no specific REFSENS requirements

6.26.2 Specific for 2 bands UL CA

6.26.2.1 UE co-existence studies

Table 6.26.2.1-1 lists Band n8 + Band n39 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.26.2.1-1: Band n8 and Band n39 2UL bands IMD products

UE UL carriers	fx_low	fx_high	<bfy_low< b=""></bfy_low<>	fy_high
UL frequency (MHz)	880	915	1880	1920
2 nd order IMD products	fy_low - fx_high	fy_high - fx_low	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	965 - 1040		2760 - 2835	
Two-tone 3 rd order IMD products	2*fx_low - fy_high	2*fx_high - fy_low	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	0 - 160		2845 - 2960	
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	3640 - 3750		4640 - 4755	
Two-tone 4 th order IMD products	3*fx_low - 1*fy_high	3*fx_high - 1*fy_low	3*fy_low - 1*fx_high	3*fy_high - 1*fx_low
IMD frequency limits (MHz)	720 - 865		4725 - 4880	
Two-tone 4 th order IMD products	2*fx_low - 2*fy_high	2*fx_high - 2*fy_low		
IMD frequency limits (MHz)	1930 - 2080			
Two-tone 4 th order IMD products	3*fx_low + 1*fy_low	3*fx_high + 1*fy_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high
IMD frequency limits (MHz)	4520 - 4665		6520 - 6675	
Two-tone 4 th order IMD products	2*fx_low + 2*fy_low	2*fx_high + 2*fy_high		
IMD frequency limits (MHz)	5520 - 5670			
Two-tone 5 th order IMD products	fx_low - 4*fy_high	fx_high - 4*fy_low	fy_low - 4*fx_high	fy_high - 4*fx_low
IMD frequency limits (MHz)	6605 - 6800		1600 - 1780	
Two-tone 5 th order IMD products	2*fx_low - 3*fy_high	2*fx_high - 3*fy_low	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)	3810 - 4000		1015 - 1200	
Two-tone 5 th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
IMD frequency limits (MHz)	8400 - 8595		5400 - 5580	
Two-tone 5 th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	7400 - 7590		6400 - 6585	

NOTE : For each IMD item, when two bound values before taking absolute have different signs, the relevant IMD range shall be set such that (1) the lower bound is 0 and (2) the upper bound is the bigger value of the two after taking absolute.

Based on the above table, there is no MSD issue due to 2UL operation for this band combination.

Table 6.26.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.26.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n8-n39	E-UTRA Band 1, 34, 40, 50, 51, 74	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 22, 41, 42 NR Band n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 8	F_{DL_low}	-	F_{DL_high}	-50	1
NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2 \text{ MHz} + N \times L_{CRB} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.						
NOTE 4: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.						

NOTE: All the tables mentioned in the note of above table are specified in TS38.101-1.

6.26.2.2 REFSENS requirements

There is no MSD issue due to IMD for this combination.

6.27 CA_n28-n77

6.27.1 Common for 1 band UL and 2 bands UL CA

6.27.1.1 Operating bands for CA

Table 6.27.1.1-1: CA band combination of band n28+n77

NR CA Band	NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode		
		BS receive / UE transmit		BS transmit / UE receive				
		$F_{UL_low} - F_{UL_high}$		$F_{DL_low} - F_{DL_high}$				
CA_n28-n77	n28	703 MHz	-	748 MHz	758 MHz	-	803 MHz	FDD
	n77	3300 MHz	-	4200 MHz	3300 MHz	-	4200 MHz	TDD

6.27.1.2 Channel bandwidths per operating band for CA

Table 6.27.1.2-1: Supported bandwidths per CA band combination of band n28+n77

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Bandwidth combination set
CA_n28A-n77A	CA_n28 A-n77A	n28	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
	n77	15			Yes	Yes	Yes			Yes	Yes					0
		30			Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
		60			Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
	CA_n28A-n77(2A)	n28	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60													
		n77	See CA_n77(2A) in Table 5.5A.2-1 in TS 38.101-1													

6.27.1.3 Co-existence studies

Table 6.27.1.3-1 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n28-n77.

Table 6.27.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		4th Harmonic		5th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n28	703	748	758	803	1406	1496	2109	2244	2812	2992	3515	3740
n77	3300	4200	3300	4200	6600	8400	9900	12600	13200	16800	16500	21000

Based on the above table, there is 5th harmonic issue for the band combination of n28 and n77.

6.27.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n28-n77, the $T_{IB,c}$ and $R_{IB,c}$ values for UEs not supporting simultaneous Rx/Tx are given in the tables below.

Table 6.27.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n28-n77	n28	0.5
	n77	0.8

Table 6.27.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n28-n77	n28	0.2
	n77	0.5

6.27.1.5 REFSENS requirements

Due to identified harmonic issues, MSD for CA_n28-n77 is derived and need to be defined in 38.101-1 as below.

Table 6.27.1.5-1: Reference sensitivity exceptions due to UL harmonic for NR CA FR1

MSD due to harmonic exception for the DL band													
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
		dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
n28	n77 ^{1, 2}		10.4	8.9	7.8			4.7	3.7	3	1.7	1.2	0.7

NOTE 1: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of a low band for which the 5th transmitter harmonic is within the downlink transmission bandwidth of a high band.

NOTE 2: The requirements should be verified for UL NR-ARFCN of a low band (superscript LB) such that $f_{UL}^{LB} = |f_{DL}^{HB}/0.5|0.1$ in MHz and $F_{ULlow}^{LB} + BW_{Channel}^{LB}/2 \leq f_{UL}^{LB} \leq F_{ULhigh}^{LB} - BW_{Channel}^{LB}/2$ with f_{DL}^{HB} the carrier frequency of a high band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the low band.

Table 6.27.1.5-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for NR CA, FR1

NR Band / Channel bandwidth of the high band													
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n28	n77		10	15	20			25	25	25	25	25	25

6.27.2 Specific for 2 bands UL CA

6.27.2.1 UE co-existence studies

Table 6.27.2.1-1 lists Band n28 + Band n77 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.28.2.1-1: Band n28 and Band n77 UL IMD products

UE UL carriers	Fx_low	Fx_high	Fy_low	Fy_high
UL frequency (MHz)	703	748	3300	4200
2nd order IMD products	fy_low - fx_high	fy_high - fx_low	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	2552	3497	4003	4948
Two-tone 3rd order IMD products	2*fx_low - fy_high	2*fx_high - fy_low	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	2794	1804	5852	7697
Two-tone 3rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	4706	5696	7303	9148
Two-tone 4th order IMD products	3*fx_low - 1*f_y_high	3*fx_high - 1*f_x_high	3*fy_low - 1*fx_low	3*fy_high - 1*fx_high

		$ 1*fy_low $		
IMD frequency limits (MHz)	2091	1056	9152	11897
Two-tone 4th order IMD products	$ 2*fx_low - 2*fy_high $	$ 2*fx_high - 2*fy_low $		
IMD frequency limits (MHz)	5104	6994		
Two-tone 4th order IMD products	$ 3*fx_low + 1*fy_low $	$ 3*fx_high + 1*fy_high $	$ 3*fy_low + 1*fx_low $	$ 3*fy_high + 1*fx_high $
IMD frequency limits (MHz)	5409	6444	10603	13348
Two-tone 4th order IMD products	$ 2*fx_low + 2*fy_low $	$ 2*fx_high + 2*fy_high $		
IMD frequency limits (MHz)	8006	9896		
Two-tone 5th order IMD products	$ fx_low - 4*fy_high $	$ fx_high - 4*fy_low $	$ fy_low - 4*fx_high $	$ fy_high - 4*fx_low $
IMD frequency limits (MHz)	16097	12452	308	1388
Two-tone 5th order IMD products	$ 2*fx_low - 3*fy_high $	$ 2*fx_high - 3*fy_low $	$ 2*fy_low - 3*fx_high $	$ 2*fy_high - 3*fx_low $
IMD frequency limits (MHz)	11194	8404	4356	6291
Two-tone 5th order IMD products	$ fx_low + 4*fy_low $	$ fx_high + 4*fy_high $	$ fy_low + 4*fx_low $	$ fy_high + 4*fx_high $
IMD frequency limits (MHz)	13903	17548	6112	7192
Two-tone 5th order IMD products	$ 2*fx_low + 3*fy_low $	$ 2*fx_high + 3*fy_high $	$ 2*fy_low + 3*fx_low $	$ 2*fy_high + 3*fx_high $
IMD frequency limits (MHz)	11306	14096	8709	10644

Based on Table 6.27.2.1-1, the 5th IMD falls down own Rx frequencies of band n28.

Table 6.27.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.27.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_28_n77	E-UTRA Band 3, 5, 7, 8, 18, 19, 20, 26, 34, 39, 40, 41	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 65	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 1	F_{DL_low}	-	F_{DL_high}	-50	1

E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	2
Frequency range	758	-	773	-32	1	
Frequency range	773	-	803	-50	1	
Frequency range	1884.5	-	1915.7	-41	0.3	1

NOTE 1: Applicable when co-existence with PHS system operating in 1884.5 - 1915.7 MHz

NOTE 2: Applicable when the assigned E-UTRA carrier is confined within 718 MHz and 748 MHz and when the channel bandwidth used is 5 or 10 MHz.

6.27.2.2 REFSENS requirements

Table 6.27.2.2-1 lists the MSD required due to 5th IMD for the dual uplink configuration.

Table 6.27.2.2-1: MSD due to IMD issue

Operating band / Channel bandwidth / N _{RB} / Duplex mode								Source of IMD
CA Configuration	Operating band	UL F _c (MHz)	UL/DL BW (MHz)	UL C _{LRB}	DL F _c (MHz)	MSD (dB)	Duplex mode	
CA_28_n77	n28	705.5	5	25	760.5	5.5	FDD	IMD5
	n77	3582.5	10	50	3582.5	N/A	TDD	N/A

6.28 CA_n1-n28

6.28.1 Common for 1 band UL and 2 bands UL CA

6.28.1.1 Operating bands for CA

Table 6.28.1.1-1: CA band combination of band n1 and n28

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
	BS receive / UE transmit		BS transmit / UE receive					
	$F_{UL_low} - F_{UL_high}$		$F_{DL_low} - F_{DL_high}$					
n1	1920 MHz – 1980 MHz		2110 MHz – 2170 MHz				TDD	
n28	703 MHz – 748 MHz		758 MHz – 803 MHz					

6.28.1.2 Channel bandwidths per operating band for CA

Table 6.28.1.2-1: Supported bandwidths per CA band combination of band n1 and n28

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Bandwidth combination set
CA_n1A-n28A	CA_n1A-n28A	n1	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
		n28	15	Yes	Yes	Yes	Yes									
			30		Yes	Yes	Yes									
			60													

6.28.1.3 UE co-existence studies

Table 6.28.1.3-1 lists up to 7th harmonics for n1A-n28A.

Table 6.28.1.3-1: Impact of UL/DL Harmonic

			2 nd Harmonic		3 rd Harmonic		4 th Harmonic		5 th Harmonic		6 th Harmonic		7 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge												
n1	1920	1980	3840	3960	5760	5940	7680	7920	9600	9900	11520	11880	13440	13860
n28	703	748	1406	1496	2109	2244	2812	2992	3515	3740	4218	4488	4921	5236

6.28.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n1-n28, the $T_{IB,c}$ and $R_{IB,c}$ values are derived from LTE combination CA_1-28 and are given in the tables below.

Table 6.28.1.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
n1-n28	n1	0.3
	n28	0.6

Table 6.28.1.4-2: $\Delta RIB,c$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
n1-n28	n1	0
	n28	0.2

6.28.1.5 REFSENS requirements

As can be seen in the co-existence studies in 6.28.1.3 the 3rd harmonics of n28 UL might affect n1 DL. MSD is defined as below.

Table 7.3A.4-1: Reference sensitivity exceptions due to UL harmonic for NR CA FR1

MSD due to harmonic exception for the DL band													
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
		dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
n28	n1 ^{6,7,8}	10.2	7.6	6.2	5.3								

NOTE 6: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of a low band for which the 3rd transmitter harmonic is within the downlink transmission bandwidth of a high band.

NOTE 7: The requirements should be verified for UL EARFCN of a low band (superscript LB) such that in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with the carrier frequency of a high band in MHz and the channel bandwidth configured in the low band.

NOTE 8: Applicable for the operations with 2 or 4 antenna ports supported in the band with carrier aggregation configured.

Table 7.3A.4-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for NR CA, FR1

6.28.2 Specific for 2 bands UL CA

6.28.2.1 UE co-existence studies

Table 6.28.2.1-1 lists Band n1 + Band n28 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.28.2.1-1: Band n1 and Band n28 UL IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	703	748	1920	1980
2nd harmonics frequency limits	2* fy_low	2* fy_high	2*fx_low	2*fx_high
2nd harmonics frequency limits (MHz)	1406	1496	3840	3960
3rd harmonics frequency limits	3* fy_low	3* fy_high	3*fx_low	3*fx_high
3rd harmonics frequency limits (MHz)	2109	2244	5760	5940
4th harmonics frequency limits	4* fy_low	4* fy_high	4*fx_low	4*fx_high
4th harmonics frequency limits (MHz)	2812	2992	7680	7920
5th harmonics frequency limits	5* fy_low	5* fy_high	5*fx_low	5*fx_high
5th harmonics frequency limits (MHz)	3515	3740	9600	9900
6th harmonics frequency limits	6* fy_low	6* fy_high	6*fx_low	6*fx_high
6th harmonics frequency limits (MHz)	4218	4488	11520	11880
7th harmonics frequency limits	7* fy_low	7* fy_high	7*fx_low	7*fx_high
7th harmonics frequency limits (MHz)	4921	5236	13440	13860
2nd order IMD products	fy_high - fx_low	fy_low - fx_high	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	1277	1172	2623	2728
3rd order IMD products	fy_high - 2*fx_low	fy_low - 2*fx_high	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	574	424	3092	3257
3rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	3326	3476	4543	4708
Two-tone 4th order IMD products	2*fx_low - 2* fy_high	2*fx_high - 2*fy_low	2*fx_low + 2* fy_low	2*fx_high + 2* fy_high
IMD frequency limits (MHz)	2554	2344	5246	5456
Two-tone 4th order IMD products	3*fx_low - 1* fy_high	3*fx_high - 1*fy_low	3*fy_low - 1*fx_high	3*fy_high - 1*fx_low
IMD frequency limits (MHz)	129	324	5012	5237
Two-tone 4th order IMD products	3*fx_low + 1* fy_low	3*fx_high + 1* fy_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high
IMD frequency limits (MHz)	4029	4224	6463	6688
Two-tone 5th order IMD products	fx_low - 4*fy_high	fx_high - 4*fy_low	fy_low - 4*fx_high	fy_high - 4*fx_low
IMD frequency limits (MHz)	7217	6932	1072	832
Two-tone 5th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
IMD frequency limits (MHz)	8383	8668	4732	4972
Two-tone 5th order IMD products	2*fx_low - 3*fy_high	2*fx_high - 3*fy_low	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)	4534	4264	1596	1851
Two-tone 5th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	7166	7436	5949	6204

Based on Table 6.28.2.1-1 there are no harmonic or IMD issues affecting own Rx frequencies of either band n1 or n28.

Table 6.28.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.28.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n1-n28	E-UTRA Band 18, 19, 27, 31, 32, 72 NR band n5, n7, n8, n20, n26, n38, n40, n41, n50, n51, n74	F _{DL_low}	-	F _{DL_high}	-50	1
	E-UTRA Band 42, 43 NR band n78, n75, n76	F _{DL_low}	-	F _{DL_high}	-50	1
	NR band n3, n34	F _{DL_low}	-	F _{DL_high}	-50	4

E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	12, 14
E-UTRA Band 65 NR band n1	F_{DL_low}	-	F_{DL_high}	-50	1	12, 13
Frequency range	470	-	694	-42	8	4, 18
Frequency range	470	-	710	-26.2	6	14
Frequency range	758	-	773	-32	1	4
Frequency range	773	-	803	-50	1	
Frequency range	662	-	694	-26.2	6	4
Frequency range	1880	-	1895	-40	1	4, 17
Frequency range	1895	-	1915	-15.5	5	4, 7, 17
Frequency range	1915	-	1920	+1.6	5	4, 7, 17
Frequency range	1839.9	-	1879.9	-50	1	4
Frequency range	1884.5	-	1915.7	-41	0.3	12, 16

NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2 \text{ MHz} + N \times \text{LCRB} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.

NOTE 4: These requirements also apply for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 and Table 6.5A.3.1-1 from the edge of the channel bandwidth.

NOTE 7: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.

NOTE 11: This requirement is applicable for any channel bandwidths within the range 2500 - 2570 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 2560.5 - 2562.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 2552 - 2560 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB.

NOTE 12: Applicable when the assigned E-UTRA carrier is confined within 718 MHz and 748 MHz and when the channel bandwidth used is 5 or 10 MHz.

NOTE 13: As exceptions, measurements with a level up to the applicable requirement of -36 dBm/MHz is permitted for each assigned E-UTRA carrier used in the measurement due to 2nd harmonic spurious emissions. An exception is allowed if there is at least one individual RB within the transmission bandwidth (see Figure 5.6-1) for which the 2nd harmonic totally or partially overlaps the measurement bandwidth (MBW).

NOTE 14: As exceptions, measurements with a level up to the applicable requirement of -38 dBm/MHz is permitted for each assigned E-UTRA carrier used in the measurement due to 3rd harmonic spurious emissions. An exception is allowed if there is at least one individual RB within the transmission bandwidth (see Figure 5.6-1) for which the 3rd harmonic totally or partially overlaps the measurement bandwidth (MBW).

NOTE 15: This requirement is applicable for 5 and 10 MHz E-UTRA channel bandwidth allocated within 718-728MHz. For carriers of 10 MHz bandwidth, this requirement applies for an uplink transmission bandwidth less than or equal to 30 RB with RBstart > 1 and RBstart<48.

NOTE 16: Applicable when NS_05 in section 6.6.3.3.1 is signalled by the network.

NOTE 17: This requirement is applicable for any channel bandwidths within the range 1920 - 1980 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 1927.5 - 1929.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 1930 - 1938 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB.

NOTE 18: This requirement is applicable in the case of a 10 MHz E-UTRA carrier confined within 703 MHz and 733 MHz, otherwise the requirement of -25 dBm with a measurement bandwidth of 8 MHz applies.

6.28.2.2 REFSENS requirements

According to the co-existence analysis in 6.28.2.1 there is no need for additional REFSENS requirements for the 2DL/2UL configuration of CA_n1A-n28A.

6.29 CA_n3-n28

6.29.1 Common for 1 band UL and 2 bands UL CA

6.29.1.1 Operating bands for CA

Table 6.29.1.1-1: CA band combination of band n3 and n28

NR Band	Uplink (UL) band				Downlink (DL) band				Duplex mode	
	BS receive / UE transmit			BS transmit / UE receive						
	$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$						
n3	1710 MHz	–	1785 MHz	1805 MHz	–	1880 MHz			TDD	
n28	703 MHz	–	748 MHz	758 MHz	–	803 MHz				

6.29.1.2 Channel bandwidths per operating band for CA

Table 6.29.1.2-1: Supported bandwidths per CA band combination of band n3 and n28

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Bandwidth combination set
CA_n3A-n28A	CA_n3A-n28A	n3	15	Yes	Yes	Yes	Yes	Yes	Yes							0
			30		Yes	Yes	Yes	Yes	Yes							
			60		Yes	Yes	Yes	Yes	Yes							
		n28	15	Yes	Yes	Yes	Yes									
			30		Yes	Yes	Yes									
			60													

6.29.1.3 UE co-existence studies

Table 6.29.1.3-1 lists up to 7th harmonics for n3A-n28A.

Table 6.29.1.3-1: Impact of UL/DL Harmonic

			2 nd Harmonic		3 rd Harmonic		4 th Harmonic		5 th Harmonic		6 th Harmonic		7 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n3	1710	1785	3420	3570	5130	5355	6840	7140	8550	8925	10260	10710	11970	12495
n28	703	748	1406	1496	2109	2244	2812	2992	3515	3740	4218	4488	4921	5236

6.29.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n3-n28, the $T_{IB,c}$ and $R_{IB,c}$ values are derived from LTE combination CA_3-28 and are given in the tables below.

Table 6.29.1.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
n3-n28	n3	0.3
	n28	0.3

Table 6.29.1.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,C}$ [dB]
n3-n28	n3	0
	n28	0

6.29.1.5 REFSENS requirements

According to the co-existence analysis in 6.29.1.3 there is no need for additional REFSENS requirements for the 2DL/1UL configuration of CA_n3A-n28A.

6.29.2 Specific for 2 bands UL CA

6.29.2.1 UE co-existence studies

Table 6.29.2.1-1 lists Band n3 + Band n28 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.29.2.1-1: Band n3 and Band n28 UL IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	703	748	1710	1785
2nd harmonics frequency limits	2* fy_low	2* fy_high	2*fx_low	2*fx_high
2nd harmonics frequency limits (MHz)	1406	1496	3420	3570
3rd harmonics frequency limits	3* fy_low	3* fy_high	3*fx_low	3*fx_high
3rd harmonics frequency limits (MHz)	2109	2244	5130	5355
4th harmonics frequency limits	4* fy_low	4* fy_high	4*fx_low	4*fx_high
4th harmonics frequency limits (MHz)	2812	2992	6840	7140
5th harmonics frequency limits	5* fy_low	5* fy_high	5*fx_low	5*fx_high
5th harmonics frequency limits (MHz)	3515	3740	8550	8925
6th harmonics frequency limits	6* fy_low	6* fy_high	6*fx_low	6*fx_high
6th harmonics frequency limits (MHz)	4218	4488	10260	10710
7th harmonics frequency limits	7* fy_low	7* fy_high	7*fx_low	7*fx_high
7th harmonics frequency limits (MHz)	4921	5236	11970	12495
2nd order IMD products	fy_high - fx_low	fy_low - fx_high	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	1082	962	2413	2533
3rd order IMD products	fy_high - 2*fx_low	fy_low - 2*fx_high	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	379	214	2672	2867
3rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	3116	3281	4123	4318
Two-tone 4th order IMD products	2*fx_low - 2* fy_high	2*fx_high - 2*fy_low	2*fx_low + 2* fy_low	2*fx_high + 2* fy_high
IMD frequency limits (MHz)	2164	1924	4826	5066
Two-tone 4th order IMD products	3*fx_low - 1* fy_high	3*fx_high - 1*fy_low	3*fy_low - 1*fx_high	3*fy_high - 1*fx_low
IMD frequency limits (MHz)	324	534	4382	4652
Two-tone 4th order IMD products	3*fx_low + 1* fy_low	3*fx_high + 1* fy_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high
IMD frequency limits (MHz)	3819	4029	5833	6103
Two-tone 5th order IMD products	fx_low - 4*fy_high	fx_high - 4*fy_low	fy_low - 4*fx_high	fy_high - 4*fx_low
IMD frequency limits (MHz)	6437	6092	1282	1027
Two-tone 5th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
IMD frequency limits (MHz)	7543	7888	4522	4777
Two-tone 5th order IMD products	2*fx_low - 3*fy_high	2*fx_high - 3*fy_low	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)	3949	3634	1176	1461
Two-tone 5th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	6536	6851	5529	5814

Based on Table 6.29.2.1-1 there are no harmonic or IMD issues affecting own Rx frequencies of either band n3 or n28.

Table 6.29.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.29.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n3-n28	E-UTRA Band 18, 19, 27, 31, 32, 72 NR band n5, n7, n8, n20, n26, n38, n40, n41, n50, n51, n74	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band42, 43 NR band n78, n75, n76	F_{DL_low}	-	F_{DL_high}	-50	1
	NR band n3, n34	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 65 NR band n1	F_{DL_low}	-	F_{DL_high}	-50	1
	Frequency range	470	-	694	-42	8
	Frequency range	470	-	710	-26.2	6
	Frequency range	758	-	773	-32	1
	Frequency range	773	-	803	-50	1
	Frequency range	662	-	694	-26.2	6
	Frequency range	1880	-	1895	-40	1
	Frequency range	1895	-	1915	-15.5	5
	Frequency range	1915	-	1920	+1.6	5
	Frequency range	1839.9	-	1879.9	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3
						12, 16

- NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2 \text{ MHz} + N \times \text{LCRB} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.
- NOTE 4: These requirements also apply for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 and Table 6.5A.3.1-1 from the edge of the channel bandwidth.
- NOTE 7: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.
- NOTE 11: This requirement is applicable for any channel bandwidths within the range 2500 - 2570 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 2560.5 - 2562.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 2552 - 2560 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB.
- NOTE 12: Applicable when the assigned E-UTRA carrier is confined within 718 MHz and 748 MHz and when the channel bandwidth used is 5 or 10 MHz.
- NOTE 13: As exceptions, measurements with a level up to the applicable requirement of -36 dBm/MHz is permitted for each assigned E-UTRA carrier used in the measurement due to 2nd harmonic spurious emissions. An exception is allowed if there is at least one individual RB within the transmission bandwidth (see Figure 5.6-1) for which the 2nd harmonic totally or partially overlaps the measurement bandwidth (MBW).
- NOTE 14: As exceptions, measurements with a level up to the applicable requirement of -38 dBm/MHz is permitted for each assigned E-UTRA carrier used in the measurement due to 3rd harmonic spurious emissions. An exception is allowed if there is at least one individual RB within the transmission bandwidth (see Figure 5.6-1) for which the 3rd harmonic totally or partially overlaps the measurement bandwidth (MBW).
- NOTE 15: This requirement is applicable for 5 and 10 MHz E-UTRA channel bandwidth allocated within 718-728MHz. For carriers of 10 MHz bandwidth, this requirement applies for an uplink transmission bandwidth less than or equal to 30 RB with RBstart > 1 and RBstart<48.
- NOTE 16: Applicable when NS_05 in section 6.6.3.3.1 is signalled by the network.
- NOTE 17: This requirement is applicable for any channel bandwidths within the range 1920 - 1980 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 1927.5 - 1929.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 1930 - 1938 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB.
- NOTE 18: This requirement is applicable in the case of a 10 MHz E-UTRA carrier confined within 703 MHz and 733 MHz, otherwise the requirement of -25 dBm with a measurement bandwidth of 8 MHz applies.

6.29.2.2 REFSENS requirements

According to the co-existence analysis in 6.29.2.1 there is no need for additional REFSENS requirements for the 2DL/2UL configuration of CA_n3A-n28A.

6.30 CA_n7-n28

6.30.1 Common for 1 band UL and 2 bands UL CA

6.30.1.1 Operating bands for CA

Table 6.30.1.1-1: CA band combination of band n7 and n28

NR Band	Uplink (UL) band				Downlink (DL) band				Duplex mode	
	BS receive / UE transmit			BS transmit / UE receive						
	$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$						
n7	2500 MHz	–	2570 MHz	2620 MHz	–	2690 MHz			TDD	
n28	703 MHz	–	748 MHz	758 MHz	–	803 MHz				

6.30.1.2 Channel bandwidths per operating band for CA

Table 6.30.1.2-1: Supported bandwidths per CA band combination of band n7 and n28

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Bandwidth combination set
CA_n7A-n28A	CA_n7A-n28A	n7	15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes					0
			30		Yes											
			60		Yes											
		n28	15	Yes	Yes	Yes	Yes									
			30		Yes	Yes	Yes									
			60													

6.30.1.3 UE co-existence studies

Table 6.30.1.3-1 lists up to 7th harmonics for n7A-n28A.

Table 6.30.1.3-1: Impact of UL/DL Harmonic

			2 nd Harmonic		3 rd Harmonic		4 th Harmonic		5 th Harmonic		6 th Harmonic		7 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n7	2500	2570	5000	5140	7500	7710	10000	10280	12500	12850	15000	15420	17500	17990
n28	703	748	1406	1496	2109	2244	2812	2992	3515	3740	4218	4488	4921	5236

6.30.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n7-n28, the $T_{IB,c}$ and $R_{IB,c}$ values are derived from LTE combination CA_7-28 and are given in the tables below.

Table 6.30.1.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
n7-n28	n7	0.3
	n28	0.3

Table 6.30.1.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,C}$ [dB]
n7-n28	n7	0
	n28	0

6.30.1.5 REFSENS requirements

According to the co-existence analysis in 6.30.1.3 there is no need for additional REFSENS requirements for the 2DL/1UL configuration of CA_n7A-n28A.

6.30.2 Specific for 2 bands UL CA

6.30.2.1 UE co-existence studies

Table 6.30.2.1-1 lists Band n7 + Band n28 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.30.2.1-1: Band n7 and Band n28 UL IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	703	748	2500	2570
2nd harmonics frequency limits	2* fy_low	2* fy_high	2*fx_low	2*fx_high
2nd harmonics frequency limits (MHz)	1406	1496	5000	5140
3rd harmonics frequency limits	3* fy_low	3* fy_high	3*fx_low	3*fx_high
3rd harmonics frequency limits (MHz)	2109	2244	7500	7710
4th harmonics frequency limits	4* fy_low	4* fy_high	4*fx_low	4*fx_high
4th harmonics frequency limits (MHz)	2812	2992	10000	10280
5th harmonics frequency limits	5* fy_low	5* fy_high	5*fx_low	5*fx_high
5th harmonics frequency limits (MHz)	3515	3740	12500	12850
6th harmonics frequency limits	6* fy_low	6* fy_high	6*fx_low	6*fx_high
6th harmonics frequency limits (MHz)	4218	4488	15000	15420
7th harmonics frequency limits	7* fy_low	7* fy_high	7*fx_low	7*fx_high
7th harmonics frequency limits (MHz)	4921	5236	17500	17990
2nd order IMD products	fy_high - fx_low	fy_low - fx_high	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	1867	1752	3203	3318
3rd order IMD products	fy_high - 2*fx_low	fy_low - 2*fx_high	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	1164	1004	4252	4437
3rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	3906	4066	5703	5888
Two-tone 4th order IMD products	2*fx_low - 2* fy_high	2*fx_high - 2*fy_low	2*fx_low + 2* fy_low	2*fx_high + 2* fy_high
IMD frequency limits (MHz)	3734	3504	6406	6636
Two-tone 4th order IMD products	3*fx_low - 1* fy_high	3*fx_high - 1*fy_low	3*fy_low - 1*fx_high	3*fy_high - 1*fx_low
IMD frequency limits (MHz)	461	256	6752	7007
Two-tone 4th order IMD products	3*fx_low + 1* fy_low	3*fx_high + 1* fy_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high
IMD frequency limits (MHz)	4609	4814	8203	8458
Two-tone 5th order IMD products	fx_low - 4*fy_high	fx_high - 4*fy_low	fy_low - 4*fx_high	fy_high - 4*fx_low
IMD frequency limits (MHz)	9577	9252	492	242
Two-tone 5th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
IMD frequency limits (MHz)	10703	11028	5312	5562
Two-tone 5th order IMD products	2*fx_low - 3*fy_high	2*fx_high - 3*fy_low	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)	6304	6004	2756	3031
Two-tone 5th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	8906	9206	7109	7384

Based on Table 6.30.2.1-1 there are no harmonic or IMD issues affecting own Rx frequencies of either band n7 or n28.

Table 6.30.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.30.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n7-n28	E-UTRA Band 27, 31, 72 NR band n2, n3, n5, n7, n8, n20, n26, n34, n40	F _{DL_low}	-	F _{DL_high}	-50	1
	E-UTRA Band 4, 10, 42, 43, 65 NR band n1, n50, n51, n66, n74, n75, n76, n78	F _{DL_low}	-	F _{DL_high}	-50	1
	NR band n1	F _{DL_low}	-	F _{DL_high}	-50	1
	Frequency range	758	-	773	-32	1
	Frequency range	773	-	803	-50	1
	Frequency range	2570	-	2575	+1.6	5
	Frequency range	2575	-	2595	-15.5	5
	Frequency range	2595	-	2620	-40	1
NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5 th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of (2 MHz + N x LCRB x 180kHz), where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.						
NOTE 4: These requirements also apply for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 and Table 6.5A.3.1-1 from the edge of the channel bandwidth.						
NOTE 7: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.						
NOTE 11: This requirement is applicable for any channel bandwidths within the range 2500 - 2570 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 2560.5 - 2562.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 2552 - 2560 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB.						
NOTE 12: Applicable when the assigned E-UTRA carrier is confined within 718 MHz and 748 MHz and when the channel bandwidth used is 5 or 10 MHz.						
NOTE 13: As exceptions, measurements with a level up to the applicable requirement of -36 dBm/MHz is permitted for each assigned E-UTRA carrier used in the measurement due to 2nd harmonic spurious emissions. An exception is allowed if there is at least one individual RB within the transmission bandwidth (see Figure 5.6-1) for which the 2nd harmonic totally or partially overlaps the measurement bandwidth (MBW).						

6.30.2.2 REFSENS requirements

According to the co-existence analysis in 6.30.2.1 there is no need for additional REFSENS requirements for the 2DL/2UL configuration of CA_n7A-n28A.

6.31 CA_n20-n28

6.31.1 Common for 1 band UL and 2 bands UL CA

6.31.1.1 Operating bands for CA

Table 6.31.1.1-1: CA band combination of band n20 and n28

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
	BS receive / UE transmit			BS transmit / UE receive				
	$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$				
n20	832 MHz	–	862 MHz	791 MHz	–	821 MHz	TDD	
n28 ¹	703 MHz	–	748 MHz	758 MHz	–	803 MHz		

NOTE 1: The frequency range in band n28 is restricted for this CA band combination to 703-733 MHz for the UL and 758-788 MHz for the DL

6.31.1.2 Channel bandwidths per operating band for CA

Table 6.31.1.2-1: Supported bandwidths per CA band combination of band n20 and n28

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Bandwidth combination set
CA_n20A-n28A ¹	CA_n20A-n28A	n20	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60													
		n28	15	Yes	Yes	Yes	Yes									
			30		Yes	Yes	Yes									
			60													

NOTE 1: The frequency range in band n28 is restricted for this CA band combination to 703-733 MHz for the UL and 758-788 MHz for the DL

6.31.1.3 UE co-existence studies

Table 6.31.1.3-1 lists up to 7th harmonics for n20A-n28A.

Table 6.31.1.3-1: Impact of UL/DL Harmonic

	2 nd Harmonic		3 rd Harmonic		4 th Harmonic		5 th Harmonic		6 th Harmonic		7 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n20	832	862	1664	1724	2496	2586	3328	3448	4160	4310	4992	5172
n28	703	733	1406	1466	2109	2199	2812	2932	3515	3665	4218	4398

6.31.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n20-n28, the $T_{IB,c}$ and $R_{IB,c}$ values are derived from LTE combination CA_20-28 and are given in the tables below.

Table 6.31.1.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
n20-n28	n20	0.5
	n28	0.5

Table 6.31.1.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
n20-n28	n20	0
	n28	0

6.31.1.5 REFSENS requirements

According to the co-existence analysis in 6.31.1.3 there is no need for additional REFSENS requirements for the 2DL/1UL configuration of CA_n20A-n28A.

6.31.2 Specific for 2 bands UL CA

6.31.2.1 UE co-existence studies

Table 6.31.2.1-1 lists Band n20 + Band n28 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

In below analysis the frequency range in band n28 is restricted to 703-733 MHz for the UL and 758-788 MHz for the DL

Table 6.31.2.1-1: Band n20 and Band n28 UL IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	703	733	832	862
2nd harmonics frequency limits	$2 * fy_low$	$2 * fy_high$	$2 * fx_low$	$2 * fx_high$
2nd harmonics frequency limits (MHz)	1406	1466	1664	1724
3rd harmonics frequency limits	$3 * fy_low$	$3 * fy_high$	$3 * fx_low$	$3 * fx_high$
3rd harmonics frequency limits (MHz)	2109	2199	2496	2586
4th harmonics frequency limits	$4 * fy_low$	$4 * fy_high$	$4 * fx_low$	$4 * fx_high$
4th harmonics frequency limits (MHz)	2812	2932	3328	3448
5th harmonics frequency limits	$5 * fy_low$	$5 * fy_high$	$5 * fx_low$	$5 * fx_high$
5th harmonics frequency limits (MHz)	3515	3665	4160	4310
6th harmonics frequency limits	$6 * fy_low$	$6 * fy_high$	$6 * fx_low$	$6 * fx_high$
6th harmonics frequency limits (MHz)	4218	4398	4992	5172
7th harmonics frequency limits	$7 * fy_low$	$7 * fy_high$	$7 * fx_low$	$7 * fx_high$
7th harmonics frequency limits (MHz)	4921	5131	5824	6034
2nd order IMD products	$ fy_high - fx_low $	$ fy_low - fx_high $	$ fy_low + fx_low $	$ fy_high + fx_high $
IMD frequency limits (MHz)	159	99	1535	1595
3rd order IMD products	$ fy_high - 2 * fx_low $	$ fy_low - 2 * fx_high $	$ 2 * fy_low - fx_high $	$ 2 * fy_high - fx_low $
IMD frequency limits (MHz)	544	634	931	1021
3rd order IMD products	$ 2 * fx_low + fy_low $	$ 2 * fx_high + fy_high $	$ 2 * fy_low + fx_low $	$ 2 * fy_high + fx_high $
IMD frequency limits (MHz)	2238	2328	2367	2457
Two-tone 4th order IMD products	$ 2 * fx_low - 2 * fy_high $	$ 2 * fx_high - 2 * fy_low $	$ 2 * fx_low + 2 * fy_low $	$ 2 * fx_high + 2 * fy_high $
IMD frequency limits (MHz)	318	198	3070	3190
Two-tone 4th order IMD products	$ 3 * fx_low - 1 * fy_high $	$ 3 * fx_high - 1 * fy_low $	$ 3 * fy_low - 1 * fx_high $	$ 3 * fy_high - 1 * fx_low $
IMD frequency limits (MHz)	1247	1367	1763	1883
Two-tone 4th order IMD products	$ 3 * fx_low + 1 * fy_low $	$ 3 * fx_high + 1 * fy_high $	$ 3 * fy_low + 1 * fx_low $	$ 3 * fy_high + 1 * fx_high $
IMD frequency limits (MHz)	2941	3061	3199	3319
Two-tone 5th order IMD products	$ fx_low - 4 * fy_high $	$ fx_high - 4 * fy_low $	$ fy_low - 4 * fx_high $	$ fy_high - 4 * fx_low $
IMD frequency limits (MHz)	2745	2595	2100	1950
Two-tone 5th order IMD products	$ fx_low + 4 * fy_low $	$ fx_high + 4 * fy_high $	$ fy_low + 4 * fx_low $	$ fy_high + 4 * fx_high $
IMD frequency limits (MHz)	4031	4181	3644	3794
Two-tone 5th order IMD products	$ 2 * fx_low - 3 * fy_high $	$ 2 * fx_high - 3 * fy_low $	$ 2 * fy_low - 3 * fx_high $	$ 2 * fy_high - 3 * fx_low $
IMD frequency limits (MHz)	1180	1030	535	385
Two-tone 5th order IMD products	$ 2 * fx_low + 3 * fy_low $	$ 2 * fx_high + 3 * fy_high $	$ 2 * fy_low + 3 * fx_low $	$ 2 * fy_high + 3 * fx_high $
IMD frequency limits (MHz)	3902	4052	3773	3923

Based on Table 6.31.2.1-1 there are no harmonic or IMD issues affecting own Rx frequencies of either band n20 or n28.

Table 6.31.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.31.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n20-n28	E-UTRA Band 1, 3, 7, 22, 28, 31, 32, 34, 38, 42, 43, 65, 75, 76, n78	F_{DL_low}	-	F_{DL_high}	-50	1

6.31.2.2 REFSENS requirements

According to the co-existence analysis in 6.31.2.1 there is no need for additional REFSENS requirements for the 2DL/2UL configuration of CA_n20A-n28A.

6.32 CA_n48-n66, CA_n48-n48-n66

6.32.1 Common for 1 band UL and 2 bands UL CA

6.32.1.1 Operating bands for CA

Table 6.32.1.1-1: CA band combination of band n48+n66

NR CA Band	NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
		BS receive / UE transmit		BS transmit / UE receive			
		$F_{UL_low} - F_{UL_high}$		$F_{DL_low} - F_{DL_high}$			
CA_n48-n66	n48	3550 MHz – 3700 MHz		3550 MHz – 3700 MHz		TDD	
	n66	1710 MHz – 1780 MHz		2110 MHz – 2200 MHz		FDD	

6.32.1.2 Channel bandwidths per operating band for CA

Table 6.32.1.2-1: Supported bandwidths per CA band combination of band n48+n66

CA operating / channel bandwidth [MHz]																
NR CA configuration	NR Uplink CA configuration	NR Band	SCS (kHz)	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n48A-n66A	CA_n48A-n66A	n48	15	Yes	Yes	Yes	Yes			Yes	Yes ¹					0
			30		Yes	Yes	Yes			Yes	Yes ¹					
			60		Yes	Yes	Yes			Yes	Yes ¹					
		n66	15	Yes	Yes	Yes	Yes			Yes						0
			30		Yes	Yes	Yes			Yes						
			60		Yes	Yes	Yes			Yes						
CA_n48C-n66A	CA_n48A-n66A	n48	See CA_n48C Bandwidth Combination in Table 5.5A.1-1 of 38.101-1													0
		n66	15	Yes	Yes	Yes	Yes			Yes						
			30		Yes	Yes	Yes			Yes						
			60		Yes	Yes	Yes			Yes						
CA_n48(2A)-n66A	CA_n48A-n66A	n48	See CA_n48(2A) Bandwidth Combination in Table 5.5A.2-1 of 38.101-1													0
		n66	15	Yes	Yes	Yes	Yes			Yes						
			30		Yes	Yes	Yes			Yes						
			60		Yes	Yes	Yes			Yes						

Note 1: This UE channel bandwidth is applicable only to DL

6.32.1.3 Co-existence studies

Table 6.32.1.3-1 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n48-n66.

Table 6.32.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		4th Harmonic		5th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n48	3550	3700	3550	3700	7100	7400	10650	11100	14200	14800	17750	18500
n66	1710	1780	2110	2200	3420	3560	5130	5340	6840	7120	8550	8900

Based on Table 6.32.1.3-1, it can be seen that the 2nd harmonic interference for band n66 UL will impact the receive frequency of n48.

6.32.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n48-n66, the $T_{IB,c}$ and $R_{IB,c}$ values for UEs are given in the tables below.

Table 6.32.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n48-n66	n48	0.8
CA_n48-n48-n66	n66	0.6

Table 6.32.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n48-n66	n48	0.5
CA_n48-n48-n66	n66	0.2

6.32.1.5 REFSEN requirements

Due to identified harmonic issues, MSD for CA_n48-n66 is derived and need to be defined in 38.101-1 as below.

Table 6.32.1.5-1: Reference sensitivity exceptions due to UL harmonic for NR CA FR1

MSD due to harmonic exception for the DL band													
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
		dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
n66	n48 ^{1, 2}	27.1	23.9	22.1	20.9			17.9	16.9 ⁴	16.1 ⁴	14.8 ⁴	14.3 ⁴	13.8 ⁴
	n48 ³	1.9	1.1	0.8	0.3								

NOTE 1: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (lower) band for which the 2nd transmitter harmonic is within the downlink transmission bandwidth of a victim (higher) band and a range ΔF_{HD} above and below the edge of this downlink transmission bandwidth. The value ΔF_{HD} depends on the band combination: $\Delta F_{HD} = 10$ MHz for CA_n48-n66.

NOTE 2: The requirements should be verified for UL NR-ARFCN of the aggressor (lower) band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.2 \rfloor + 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{HB} carrier frequency in the victim (higher) band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the lower band.

NOTE 3: The requirements are only applicable to channel bandwidths no larger than 20 MHz and with a carrier frequency at $\pm(20 + BW_{Channel}^{HB} / 2)$ MHz offset from $2f_{UL}^{LB}$ in the victim (higher band) with $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$, where $BW_{Channel}^{LB}$ and $BW_{Channel}^{HB}$ are the channel bandwidths configured in the aggressor (lower) and victim (higher) bands in MHz, respectively.

NOTE 4: For these bandwidths, the minimum requirements are restricted to operation when carrier is configured as a downlink carrier part of CA configuration

Table 6.32.1.5-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for NR CA, FR1

NR Band / Channel bandwidth of the high band													
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n66	n48	12	25	36	50			100	128	160	200	200	200

6.32.2 Specific for 2 bands UL CA

6.32.2.1 UE co-existence studies

Table 6.32.2.1-1 lists Band n48 + Band n66 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.32.2.1-1: Band n48 and Band n66 UL IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	1710	1780	3550	3700
2nd order IMD products	$ fy_{high} - fx_{low} $	$ fy_{low} - fx_{high} $	$ fy_{low} + fx_{low} $	$ fy_{high} + fx_{high} $
IMD frequency limits (MHz)	1990	1770	5260	5480
3rd order IMD products	$ fy_{high} - 2*fx_{low} $	$ fy_{low} - 2*fx_{high} $	$ 2*fy_{low} - fx_{high} $	$ 2*fy_{high} - fx_{low} $
IMD frequency limits (MHz)	280	10	5320	5690
3rd order IMD products	$ 2*fx_{low} + fy_{low} $	$ 2*fx_{high} + fy_{high} $	$ 2*fy_{low} + fx_{low} $	$ 2*fy_{high} + fx_{high} $
IMD frequency limits (MHz)	6970	7260	8810	9180
Two-tone 4th order IMD products	$ 2*fx_{low} - 2*fy_{high} $	$ 2*fx_{high} - 2*fy_{low} $	$ 2*fx_{low} + 2*fy_{low} $	$ 2*fx_{high} + 2*fy_{high} $
IMD frequency limits (MHz)	3980	3540	10520	10960
Two-tone 4th order IMD products	$ 3*fx_{low} - 1*fy_{high} $	$ 3*fx_{high} - 1*fy_{low} $	$ 3*fy_{low} - 1*fx_{high} $	$ 3*fy_{high} - 1*fx_{low} $
IMD frequency limits (MHz)	1430	1790	8870	9390
Two-tone 4th order IMD products	$ 3*fx_{low} + 1*fy_{low} $	$ 3*fx_{high} + 1*fy_{high} $	$ 3*fy_{low} + 1*fx_{low} $	$ 3*fy_{high} + 1*fx_{high} $
IMD frequency limits (MHz)	8680	9040	12360	12880
Two-tone 5th order IMD products	$ fx_{low} - 4*fy_{high} $	$ fx_{high} - 4*fy_{low} $	$ fy_{low} - 4*fx_{high} $	$ fy_{high} - 4*fx_{low} $
IMD frequency limits (MHz)	13090	12420	3570	3140
Two-tone 5th order IMD products	$ fx_{low} + 4*fy_{low} $	$ fx_{high} + 4*fy_{high} $	$ fy_{low} + 4*fx_{low} $	$ fy_{high} + 4*fx_{high} $
IMD frequency limits (MHz)	15910	16580	10390	10820
Two-tone 5th order IMD products	$ 2*fx_{low} - 3*fy_{high} $	$ 2*fx_{high} - 3*fy_{low} $	$ 2*fy_{low} - 3*fx_{high} $	$ 2*fy_{high} - 3*fx_{low} $
IMD frequency limits (MHz)	7680	7090	1760	2270
Two-tone 5th order IMD products	$ 2*fx_{low} + 3*fy_{low} $	$ 2*fx_{high} + 3*fy_{high} $	$ 2*fy_{low} + 3*fx_{low} $	$ 2*fy_{high} + 3*fx_{high} $
IMD frequency limits (MHz)	14070	14660	12230	12740

Based on Table 6.32.2.1-1, the 5th order IMD may also fall into Rx frequencies of band n66 and no IMD falls into its band n48 Rx frequencies since band n48 is TDD band.

Table 6.32.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.32.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n48-n66	E-UTRA Band 2, 4, 5, 7, 10, 12, 13, 14, 17, 24, 25, 26, 27, 29, 30, 41, 50, 51, 66, 70, 71, 74, 85	F _{DL_low}	-	F _{DL_high}	-50	1

6.32.2.2 REFSENS requirements

Table 6.32.2.2-1 lists the MSD required due to 5th IMD for the dual uplink configuration.

Table 6.32.2.2-1: MSD due to IMD issue

Operating band / Channel bandwidth / N _{RB} / Duplex mode								Source of IMD
CA Configuration	Operating band	UL F _c (MHz)	UL/DL BW (MHz)	UL C _{LRB}	DL F _c (MHz)	MSD (dB)	Duplex mode	
CA_n48A-n66A CA_n48C-n66A CA_n48(2A)-n66A	n48	3660	5	25	3660	N/A	TDD	N/A
	n66	1730	5	25	2130	5.0	FDD	IMD5

6.33 CA_n7-n78

6.33.1 Common for 1 band UL and 2 bands UL CA

6.33.1.1 Operating bands for CA

Table 6.33.1-1: CA band combination of band n7 + n78

NR CA Band Combination	NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
		BS receive / UE transmit			BS transmit / UE receive				
		F _{UL_low} – F _{UL_high}	F _{DL_low} – F _{DL_high}						
CA_n7-n78	n7	2500 MHz – 2570 MHz		2620 MHz – 2690 MHz				FDD	
	n78	3300 MHz – 3800 MHz		3300 MHz – 3800 MHz				TDD	

6.33.1.2 Channel bandwidths per operating band for CA

Table 6.33.1: Supported bandwidths per CA band combination of band n7+n78

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n7A-n78A	CA_n7A-n78A	n7	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
		n78	15		Yes	Yes	Yes			Yes	Yes					0
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
CA_n7A-n78(2A)	CA_n7A-n78A	n7	15	Yes					0							
			30		Yes											
			60		Yes											
		n78	See CA_n78(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1 from 38.101-1													
CA_n7(2A)-n78A	CA_n7A-n78A	n7	See CA_n7(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1 from 38.101-1													0
		n78	15		Yes	Yes	Yes		Yes	Yes						
			30		Yes	Yes	Yes		Yes							
			60		Yes	Yes	Yes		Yes							
CA_n7(2A)-n78(2A)	CA_n7A-n78A	n7	See CA_n7(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1 from 38.101-1													0
		n78	See CA_n78(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1 from 38.101-1													

6.33.1.3 Co-existence studies

Table 6.33.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n7-n78.

Table 6.33.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		4th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n7	2500	2570	2620	2690	5000	5140	7500	7710	10000	10280
n78	3300	3800	3300	3800	6600	7600	9900	11400	13200	15200

Based on above table, there is no harmonics issue for the band combination of n7 and n78.

Table 6.33.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic			3rd Harmonic		m th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	
n7	2500	2570	2620	2690	5240	5380	7860	8070			
n78	3300	3800	3300	3800	6600	7600	9900	11400			

Based on above table, there is no harmonics mixing issue for the band combination of n7 and n78.

6.33.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n7-n78, the $T_{IB,c}$ and R_{IB} can follow the values of DC_7_n78. The values are given in the tables below.

Table 6.33.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n7-n78	n7	0.5
	n78	0.8

Table 6.33.1.4-2: ΔR_{IB}

Inter-band CA Configuration	NR Band	ΔR_{IB} [dB]
CA_n7-n78	n7	0.5
	n78	0.5

6.33.1.5 REFSENs requirements

The MSD for cross band Tx-Rx interference is shown below.

Table 6.33.1.5-1: MSD for the CA configuration for asynchronous operation and cross band isolation for CA

NR Band / Channel bandwidth of the affected DL band														
NR CA Configuration	UL band	DL band	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	30 MHz (dB)	40 MHz (dB)	50 MHz (dB)	60 MHz (dB)	80 MHz (dB)	90 MHz (dB)	100 MHz (dB)
CA_n7A-n78A CA_n7A-n78(2A)	n78	n7 ¹	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5				

NOTE 1: Applicable only when harmonic mixing MSD for this combination is not applied.
 NOTE 2: Void

Table 6.33.1.5-2: Uplink configuration for reference sensitivity exceptions due to cross band isolation for CA

NR Band / SCS / Channel bandwidth of the affected DL band														
UL band	DL band	SCS of UL band (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n78	n7	30	270	270	270	270	270	270	270	270				

NOTE 1: The UL configuration applies regardless of the channel bandwidth of the UL band unless the UL resource blocks exceed that specified in Table 7.3.2-3 for the uplink bandwidth in which case the allocation according to Table 7.3.2-3 applies.
 NOTE 2: Refers to 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 in Table 5.3.2-1.

6.33.2 Specific for 2 bands UL CA

6.33.2.1 UE co-existence studies

Table 6.33.2.1-1 gives IMD interference analysis for CA_n7-n78 with 2 ULs.

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	2500	2570	3300	3800
2 nd harmonics frequency limits (MHz)	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2 nd harmonics frequency limits (MHz)	5000	5140	6600	7600
3 rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3 rd harmonics frequency limits (MHz)	7500	7710	9900	11400
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	10000	10280	13200	15200
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	12500	12850	16500	19000
2 nd order IMD products	fy_low - fx_high	fy_high - fx_low	fy_low + fx_low	fy_high + fx_high

IMD frequency limits (MHz)	730	1300	5800	6370
Two-tone 3 rd order IMD products	$ 2*fx_low - fy_high $	$ 2*fx_high - fy_low $	$ 2*fy_low - fx_high $	$ 2*fy_high - fx_low $
IMD frequency limits (MHz)	1200	1840	4030	5100
Two-tone 3 rd order IMD products	$ 2*fx_low + fy_low $	$ 2*fx_high + fy_high $	$ 2*fy_low + fx_low $	$ 2*fy_high + fx_high $
IMD frequency limits (MHz)	8300	8940	9100	10170
Two-tone 4 th order IMD products	$ 3*fx_low - 1*fy_high $	$ 3*fx_high - 1*fy_low $	$ 3*fy_low - 1*fx_high $	$ 3*fy_high - 1*fx_low $
IMD frequency limits (MHz)	3700	4410	7330	8900
Two-tone 4 th order IMD products	$ 3*fx_low + 1*fy_low $	$ 3*fx_high + 1*fy_high $	$ 3*fy_low + 1*fx_low $	$ 3*fy_high + 1*fx_high $
IMD frequency limits (MHz)	10800	11510	12400	13970
Two-tone 4 th order IMD products	$ 2*fx_low - 2*fy_high $	$ 2*fx_high - 2*fy_low $	$ 2*fx_low + 2*fy_low $	$ 2*fx_high + 2*fy_high $
IMD frequency limits (MHz)	2600	1460	11600	12740
Two-tone 5 th order IMD products	$ fx_low - 4*fy_high $	$ fx_high - 4*fy_low $	$ fy_low - 4*fx_high $	$ fy_high - 4*fx_low $
IMD frequency limits (MHz)	12700	10630	6980	6200
Two-tone 5 th order IMD products	$ 2*fx_low - 3*fy_high $	$ 2*fx_high - 3*fy_low $	$ 2*fy_low - 3*fx_high $	$ 2*fy_high - 3*fx_low $
IMD frequency limits (MHz)	6400	4760	1110	100
Two-tone 5 th order IMD products	$ fx_low + 4*fy_low $	$ fx_high + 4*fy_high $	$ fy_low + 4*fx_low $	$ fy_high + 4*fx_high $
IMD frequency limits (MHz)	15700	17770	13300	14080
Two-tone 5 th order IMD products	$ 2*fx_low + 3*fy_low $	$ 2*fx_high + 3*fy_high $	$ 2*fy_low + 3*fx_low $	$ 2*fy_high + 3*fx_high $
IMD frequency limits (MHz)	14900	16540	14100	15310

Based on above table, the 4rd order IMD may fall into Rx frequencies of Band n78. However IMD is not an issue for Band n78 since it is a TDD band. There is no IMD issue for CA_n7-n78.

Table 6.33.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.33.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA Configuration	Spurious emission						
	Protected Band		Frequency range (Mhz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n7-n78	E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 10, 11, 18, 19, 20, 21, 26, 27, 28, 31, 32, 33, 34, 40, 50, 51, 65, 66, 67, 68, 72, 74, 75, 76	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	2570	-	2575	+1.6	5	4, 7, 18
	Frequency range	2575	-	2595	-15.5	5	4, 7, 18
	Frequency range	2595	-	2620	-40	1	4, 18
NOTE 4: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.							
NOTE 7: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.							
NOTE 18: This requirement is applicable for any channel bandwidths within the range 2500 – 2570 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 2560.5 – 2562.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 2552 – 2560 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB.							

6.33.2.2 REFSENS requirements

There is no MSD requirements for the dual uplink configuration without IMD issue.

6.34 CA_n7-n66

6.34.1 Common for 1 band UL and 2 bands UL CA

6.34.1.1 Operating bands for CA

Table 6.34.1-1: CA band combination of band n7 + n66

NR CA Band Combination	NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
		BS receive / UE transmit			BS transmit / UE receive				
		$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$				
CA_n7-n66	n7	2500 MHz	–	2570 MHz	2620 MHz	–	2690 MHz	FDD	
	n66	1710 MHz	–	1780 MHz	2110 MHz	–	2200 MHz	FDD	

6.34.1.2 Channel bandwidths per operating band for CA

Table 8.x.2-1: Supported bandwidths per CA band combination of band n7+n66

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n7A-n66A	CA_n7A-n66A	n7	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
		n66	15	Yes	Yes	Yes	Yes			Yes						
			30		Yes	Yes	Yes			Yes						
			60		Yes	Yes	Yes			Yes						

6.34.1.3 Co-existence studies

Table 6.34.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n7-n66.

Table 6.34.1.3-1: Impact of UL/DL Harmonic

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2nd Harmonic		3rd Harmonic		nth Harmonic	
					UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n7	2500	2570	2620	2690	5000	5140	7500	7710		
n66	1710	1780	2110	2200	3420	3560	5130	5340		

Based on above table, there is no harmonics issue for the band combination of n7 and n66.

Table 6.34.1.3-2: Impact of UL/DL Harmonic mixing

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2nd Harmonic		3rd Harmonic		mth Harmonic	
					DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n7	2500	2570	2620	2690	5240	5380	7860	8070		
n66	1710	1780	2110	2200	4220	4400	6330	6600		

Based on above table, there is no harmonics mixing issue for the band combination of n7 and n66.

6.34.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n7A-n66A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.34.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n7-n66	n7	0.5
	n66	0.5

Table 6.34.1.4-2: ΔR_{IB}

Inter-band CA Configuration	NR Band	ΔR_{IB} [dB]
CA_n7-n66	n7	0.5
	n66	0.5

6.34.1.5 REFSENs requirements

There are no specific REFSENS requirements for 1 band UL

6.34.2 Specific for 2 bands UL CA

6.34.2.1 UE co-existence studies

Table 6.34.2.1-1 gives IMD interference analysis for CA_n7-n66 with 2 ULs.

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1710	1780	2500	2570
2 nd harmonics frequency limits (MHz)	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2 nd harmonics frequency limits (MHz)	3420	3560	5000	5140
3 rd harmonics frequency limits (MHz)	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3 rd harmonics frequency limits (MHz)	5130	5340	7500	7710
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	6840	7120	10000	10280
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	8550	8900	12500	12850
Two tone 2 nd order IMD products	fy_low – fx_high	fy_high – fx_low	fx_low + fy_low	fx_high + fy_high
IMD frequency limits (MHz)	720	860	4210	4350
Two-tone 3 rd order IMD products	2*fx_low – fy_high	2*fx_high – fy_low	2*fy_low – fx_high	2*fy_high – fx_low
IMD frequency limits (MHz)	850	1060	3220	3430
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	5920	6130	6710	6920
Two-tone 4 th order IMD products	3*fx_low – fy_high	3*fx_high – fy_low	3*fy_low – fx_high	3*fy_high – fx_low
IMD frequency limits (MHz)	2560	2840	5720	6000
Two-tone 4 th order IMD products	3*fx_low + fy_low	3*fx_high + fy_high	3*fy_low + fx_low	3*fy_high + fx_high
IMD frequency limits (MHz)	7630	7910	9210	9420
Two-tone 4 th order IMD products	2*fy_low – 2*fx_high	2*fy_high – 2*fx_low	2*fx_low + 2*fy_low	2*fx_high + 2*fy_high
IMD frequency limits (MHz)	1440	1720	8420	8700
Two-tone 5 th order IMD products	4*fx_low – fy_high	4*fx_high – fy_low	4*fy_low – fx_high	4*fy_high – fx_low
IMD frequency limits (MHz)	4270	4620	8220	8570
Two-tone 5 th order IMD products	4*fx_low + fy_low	4*fx_high + fy_high	4*fy_low + fx_low	4*fy_high + fx_high
IMD frequency limits (MHz)	9340	9690	11710	12060
Two-tone 5 th order IMD products	3*fx_low – 2*fy_high	3*fx_high – 2*fy_low	3*fy_low – 2*fx_high	3*fy_high – 2*fx_low
IMD frequency limits (MHz)	10	340	3940	4290
Two-tone 5 th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	10920	11270	10130	10480

Based on above table, two-tone 4th order IMD products may fall into the own Rx Band of Band 7.

Table 6.34.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.34.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n7-n66	E-UTRA Band 2, 4, 5, 7, 10, 12, 13, 14, 17, 26, 27, 28, 29, 30, 43, 66, 71, , 85	FDL_low	-	FDL_high	-50	1
	E-UTRA Band 42	FDL_low	-	FDL_high	-50	1
	Frequency range	2570	-	2575	1.6	5
	Frequency range	2575	-	2595	-15.5	5
	Frequency range	2595	-	2620	-40	1

6.34.2.2 REFSENS requirements

The IMD issue for CA_n7-n66 is similar as LTE CA_4A-7A. Hence the MSD value for CA_4A-7A can be re-used for CA_n7-n66.

Table 6.34.2.2-1: MSD due to IMD issue

Band / Channel bandwidth / N _{RB} / Duplex mode								Source of IMD
NR CA Configuration	NR band	UL F _c (MHz)	UL/DL BW (MHz)	UL C _{LRB}	DL F _c (MHz)	MSD (dB)	Duplex mode	
CA_n7A-n66A	n7	2535	10	50	2655	15	FDD	IMD4
	n66	1730	5	25	2130	N/A	FDD	N/A

6.35 CA_n41-n66

6.35.1 Common for 1 band UL and 2 bands UL CA

6.35.1.1 Operating bands for CA

Table 6.35.1.1-1: CA band combination of band n41+n66

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
	BS receive / UE transmit		BS transmit / UE receive			
	F _{UL_low} – F _{UL_high}		F _{DL_low} – F _{DL_high}			
n41	2469 MHz	– 2690 MHz	2469 MHz	– 2690 MHz	TDD	
n66	1710 MHz	– 1780 MHz	2110 MHz	– 2200 MHz	FDD	

6.35.1.2 Channel bandwidths per operating band for CA

Table 6.35.1.2-1: Supported bandwidths per CA band combination of band n41+n66

NR CA configuration	NR Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Maximum Aggregated bandwidth [MHz]	BCS	
CA_n41A-n66A	CA_n41A-n66A	n41	15		Yes	Yes	Yes			Yes	Yes					140	0	
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes			
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes			
		n66	15	Yes	Yes	Yes	Yes			Yes								
			30		Yes	Yes	Yes			Yes								
			60		Yes	Yes	Yes			Yes								
		n41	See CA_n41(2A) Bandwidth Combination Set 1 in 38.101-1 Table 5.5A.2-1												230	0		
			15	Yes	Yes	Yes	Yes			Yes								
			30		Yes	Yes	Yes			Yes								
			60		Yes	Yes	Yes			Yes								
CA_n41(2A)-n66A	-	n66	See CA_n41C Bandwidth Combination Set 0 in 38.101-1 Table 5.5A.1-1												220	0		
			15	Yes	Yes	Yes	Yes			Yes								
			30		Yes	Yes	Yes			Yes								
			60		Yes	Yes	Yes			Yes								
		n41	See CA_n41C Bandwidth Combination Set 0 in 38.101-1 Table 5.5A.1-1															
			15	Yes	Yes	Yes	Yes			Yes								
			30		Yes	Yes	Yes			Yes								
		n66	60		Yes	Yes	Yes			Yes								

6.35.1.3 UE co-existence studies

Table 6.35.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA _ n41-n66.

Table 6.35.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		nth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n41	2496	2690	2496	2690	4992	5380	7488	8070		
n66	1710	1780	2110	2200	3420	3560	5130	5340		

Table 6.35.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic		3rd Harmonic		mth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n41	2496	2690	2496	2690	4992	5380	7488	8070		
n66	1710	1780	2110	2200	4220	4400	6330	6600		

Based on above tables, there is no harmonic issue.

6.35.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n41-n66, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values for low high combination are reused from DC_66_n41 as given in the tables below.

Table 6.35.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n41-n66	n41	0.8 ¹
		1.3 ²
	n66	0.5

NOTE 1: The requirement is applied for UE transmitting on the frequency range of 2545-2690 MHz.
 NOTE 2: The requirement is applied for UE transmitting on the frequency range of 2496-2545 MHz.

Table 6.35.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n41-n66	n41	0.5 ¹
		1 ²
	n66	0.5

NOTE 1: The requirement is applied for UE transmitting on the frequency range of 2545-2690 MHz.
 NOTE 2: The requirement is applied for UE transmitting on the frequency range of 2496-2545 MHz.

6.35.1.5 REFSENS requirements

A reference sensitivity exception (MSD) already exists in 38.101-3 due to cross band isolation for EN-DC of band n41 and 66 in NR FR1. The same should apply for CA_n41-n66 as given in Table 6.35.1.5-1 with uplink configuration specified in Table 6.35.1.5-2.

Table 6.35.1.5-1: MSD for the CA configuration for asynchronous operation and cross band isolation for CA

NR CA Configuration	NR UL band	NR DL band	Channel bandwidth											
			5 MHz (dBm)	10 MHz (dBm)	15 MHz (dBm)	20 MHz (dBm)	25 MHz (dBm)	30 MHz (dBm)	40 MHz (dBm)	50 MHz (dBm)	60 MHz (dBm)	80 MHz (dBm)	90 MHz (dBm)	100 MHz (dBm)
CA_n41-n66	n41 ¹	n66	3.5	3.5	3.5	3.5			3.5					

NOTE 1: Applicable only when harmonic mixing MSD for this combination is not applied..

Table 6.35.1.5-2: Uplink configuration for reference sensitivity exceptions due to cross band isolation for CA

Channel bandwidth of the affected DL band														
NR UL band	NR DL band	SCS of UL band (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n41	n66	30	128	128	128	128			128					

6.35.2 Specific for 2 bands UL CA

6.35.2.1 UE co-existence studies

Table 6.35.2.1-1 lists Band n41 + Band n66 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.35.2.1-1: Band n41 and Band n66 UL IMD products

UE UL carriers	fx_low	fx_high	fy_high	
2nd order IMD products	$ fy_{high} - fx_{low} $	$ fy_{low} - fx_{high} $	$ fy_{low} + fx_{low} $	$ fy_{high} + fx_{high} $
IMD frequency limits (MHz)	980	716	4206	4470
3rd order IMD products	$ fy_{high} - 2*fx_{low} $	$ fy_{low} - 2*fx_{high} $	$ 2*fy_{low} - fx_{high} $	$ 2*fy_{high} - fx_{low} $
IMD frequency limits (MHz)	730	1064	3212	3670
3rd order IMD products	$ 2*fx_{low} + fy_{low} $	$ 2*fx_{high} + fy_{high} $	$ 2*fy_{low} + fx_{low} $	$ 2*fy_{high} + fx_{high} $
IMD frequency limits (MHz)	5916	6250	6702	7160
Two-tone 4th order IMD products	$ 2*fx_{low} - 2*fy_{high} $	$ 2*fx_{high} - 2*fy_{low} $	$ 2*fx_{low} + 2*fy_{low} $	$ 2*fx_{high} + 2*fy_{high} $
IMD frequency limits (MHz)	1960	1432	8412	8940
Two-tone 4th order IMD products	$ 3*fx_{low} - 1*fy_{high} $	$ 3*fx_{high} - 1*fy_{low} $	$ 3*fy_{low} - 1*fx_{high} $	$ 3*fy_{high} - 1*fx_{low} $
IMD frequency limits (MHz)	2440	2844	5708	6360
Two-tone 4th order IMD products	$ 3*fx_{low} + 1*fy_{low} $	$ 3*fx_{high} + 1*fy_{high} $	$ 3*fy_{low} + 1*fx_{low} $	$ 3*fy_{high} + 1*fx_{high} $
IMD frequency limits (MHz)	7626	8030	9198	9850
Two-tone 5th order IMD products	$ fx_{low} - 4*fy_{high} $	$ fx_{high} - 4*fy_{low} $	$ fy_{low} - 4*fx_{high} $	$ fy_{high} - 4*fx_{low} $
IMD frequency limits (MHz)	9050	8204	4624	4150
Two-tone 5th order IMD products	$ fx_{low} + 4*fy_{low} $	$ fx_{high} + 4*fy_{high} $	$ fy_{low} + 4*fx_{low} $	$ fy_{high} + 4*fx_{high} $
IMD frequency limits (MHz)	11694	12540	9336	9810
Two-tone 5th order IMD products	$ 2*fx_{low} - 3*fy_{high} $	$ 2*fx_{high} - 3*fy_{low} $	$ 2*fy_{low} - 3*fx_{high} $	$ 2*fy_{high} - 3*fx_{low} $
IMD frequency limits (MHz)	4650	3928	348	250
Two-tone 5th order IMD products	$ 2*fx_{low} + 3*fy_{low} $	$ 2*fx_{high} + 3*fy_{high} $	$ 2*fy_{low} + 3*fx_{low} $	$ 2*fy_{high} + 3*fx_{high} $
IMD frequency limits (MHz)	10908	11630	10122	10720

Based on Table 6.35.2.1-1 there are IMD4 issues affecting own Rx frequencies of band n41.

Table 6.35.2.1-2 lists the protected bands required for the 2UL bands CA configuration as to be used in Table 6.5A.3.2.3-1 of TS 38.101-1.

Table 6.35.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n41-n66	E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 24, 25, 26, 27, 28, 29, 30, 50, 51, 66, 70, 71, 74, 85	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 42, 48	F_{DL_low}	-	F_{DL_high}	-50	1

NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2 \text{ MHz} + N \times L_{CRB} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.

6.35.2.2 REFSENS requirements

Based on the co-existence studies for CA_n41-n66 MSD does not need to be defined.

6.36 CA_n2-n48

6.36.1 Common for 1 band UL and 2 bands UL CA

6.36.1.1 Operating bands for CA

Table 6.36.1.1-1: CA band combination of band n2+n48

NR CA Band	NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
		BS receive / UE transmit		BS transmit / UE receive			
		F_{UL_low} – F_{UL_high}	F_{DL_low} – F_{DL_high}	F_{DL_low} – F_{DL_high}	F_{UL_low} – F_{UL_high}		
CA_n2-n48	n2	1850 MHz – 1910 MHz		1930 MHz – 1990 MHz		FDD	
	n48	3550 MHz – 3700 MHz		3550 MHz – 3700 MHz		TDD	

6.36.1.2 Channel bandwidths per operating band for CA

Table 6.36.1.2-1: Supported bandwidths per CA band combination of band n2+n48

CA operating / channel bandwidth [MHz]																
NR CA configuration	NR Uplink CA configuration	NR Band	SCS (kHz)	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n2A-n48A	CA_n2A-n48A	n2	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
		n48	15	Yes	Yes	Yes	Yes			Yes	Yes ¹					0
			30		Yes	Yes	Yes			Yes	Yes ¹					
			60		Yes	Yes	Yes			Yes	Yes ¹					
CA_n2A-n48C	CA_n48C CA_n2A-n48A	n2	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
		n48	See CA_n48C Bandwidth Combination in Table 5.5A.1-1 of 38.101-1													

Note 1: This UE channel bandwidth is applicable only to DL

6.36.1.3 Co-existence studies

Table 6.36.1.3-1 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n2-n48.

Table 6.36.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		4th Harmonic		5th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n2	1850	1910	1930	1990	3700	3820	5550	5730	7400	7640	9250	9550
n48	3550	3700	3550	3700	7100	7400	10650	11100	14200	14800	17750	18500

Based on Table 6.36.1.3-1, it can be seen that the 2nd harmonic skirt interference for band n2 UL will impact the receive frequency of band n48.

6.36.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n2-n48, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values for UEs are given in the tables below.

Table 6.36.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n2-n48	n2	0.6
	n48	0.8

Table 6.36.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n2-n48	n2	0.2
	n48	0.5

6.36.1.5 REFSEN requirements

Due to identified harmonic issues, MSD for CA_n2-n48 is derived and need to be defined in 38.101-1 as below.

Table 6.36.1.5-1: Reference sensitivity exceptions due to UL harmonic for NR CA FR1

MSD due to harmonic exception for the DL band													
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
		dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
n2	n48 ^{1,2}	27.1	23.9	22.1	20.9			17.9	16.9 ⁴	16.1 ⁴	14.8 ⁴	14.3 ⁴	13.8 ⁴
	n48 ³	1.9	1.1	0.8	0.3								

NOTE 1: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (lower) band for which the 2nd transmitter harmonic is within the downlink transmission bandwidth of a victim (higher) band and a range ΔF_{HD} above and below the edge of this downlink transmission bandwidth. The value ΔF_{HD} depends on the band combination: $\Delta F_{HD} = 10$ MHz for CA_n2-n48.

NOTE 2: The requirements should be verified for UL NR-ARFCN of the aggressor (lower) band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.2 \rfloor + 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{HB} carrier frequency in the victim (higher) band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the lower band.

NOTE 3: The requirements are only applicable to channel bandwidths no larger than 20 MHz and with a carrier frequency at $\pm(20 + BW_{Channel}^{HB} / 2)$ MHz offset from $2f_{UL}^{LB}$ in the victim (higher band) with $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$, where $BW_{Channel}^{LB}$ and $BW_{Channel}^{HB}$ are the channel bandwidths configured in the aggressor (lower) and victim (higher) bands in MHz, respectively.

NOTE 4: For these bandwidths, the minimum requirements are restricted to operation when carrier is configured as a downlink carrier part of CA configuration

Table 6.36.1.5-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for NR CA, FR1

NR Band / Channel bandwidth of the high band													
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n2	n48	25	50	50	50			50	50	50	50	50	50

6.36.2 Specific for 2 bands UL CA

6.36.2.1 UE co-existence studies

Table 6.36.2.1-1 lists Band n2 + Band n48 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.36.2.1-1: Band n2 and Band n48 UL IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1850	1910	3550	3700
2nd order IMD products	$ fy_{high} - fx_{low} $	$ fy_{low} - fx_{high} $	$ fy_{low} + fx_{low} $	$ fy_{high} + fx_{high} $
IMD frequency limits (MHz)	1850	1640	5400	5610
3rd order IMD products	$ fy_{high} - 2*fx_{low} $	$ fy_{low} - 2*fx_{high} $	$ 2*fy_{low} - fx_{high} $	$ 2*fy_{high} - fx_{low} $
IMD frequency limits (MHz)	0	270	5190	5550
3rd order IMD products	$ 2*fx_{low} + fy_{low} $	$ 2*fx_{high} + fy_{high} $	$ 2*fy_{low} + fx_{low} $	$ 2*fy_{high} + fx_{high} $
IMD frequency limits (MHz)	7250	7520	8950	9310
Two-tone 4th order IMD products	$ 2*fx_{low} - 2*fy_{high} $	$ 2*fx_{high} - 2*fy_{low} $	$ 2*fx_{low} + 2*fy_{low} $	$ 2*fx_{high} + 2*fy_{high} $
IMD frequency limits (MHz)	3700	3280	10800	11220
Two-tone 4th order IMD products	$ 3*fx_{low} - 1*fy_{high} $	$ 3*fx_{high} - 1*fy_{low} $	$ 3*fy_{low} - 1*fx_{high} $	$ 3*fy_{high} - 1*fx_{low} $
IMD frequency limits (MHz)	1850	2180	8740	9250
Two-tone 4th order IMD products	$ 3*fx_{low} + 1*fy_{low} $	$ 3*fx_{high} + 1*fy_{high} $	$ 3*fy_{low} + 1*fx_{low} $	$ 3*fy_{high} + 1*fx_{high} $
IMD frequency limits (MHz)	9100	9430	12500	13010
Two-tone 5th order IMD products	$ fx_{low} - 4*fy_{high} $	$ fx_{high} - 4*fy_{low} $	$ fy_{low} - 4*fx_{high} $	$ fy_{high} - 4*fx_{low} $
IMD frequency limits (MHz)	12950	12290	4090	3700
Two-tone 5th order IMD products	$ fx_{low} + 4*fy_{low} $	$ fx_{high} + 4*fy_{high} $	$ fy_{low} + 4*fx_{low} $	$ fy_{high} + 4*fx_{high} $
IMD frequency limits (MHz)	16050	16710	10950	11340
Two-tone 5th order IMD products	$ 2*fx_{low} - 3*fy_{high} $	$ 2*fx_{high} - 3*fy_{low} $	$ 2*fy_{low} - 3*fx_{high} $	$ 2*fy_{high} - 3*fx_{low} $
IMD frequency limits (MHz)	7400	6830	1370	1850
Two-tone 5th order IMD products	$ 2*fx_{low} + 3*fy_{low} $	$ 2*fx_{high} + 3*fy_{high} $	$ 2*fy_{low} + 3*fx_{low} $	$ 2*fy_{high} + 3*fx_{high} $
IMD frequency limits (MHz)	14350	14920	12650	13130

Based on Table 6.36.2.1-1, the 4th order IMD may also fall into Rx frequencies of band n2 and no IMD falls into its band n48 Rx frequencies since band n48 is TDD band.

Table 6.36.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.36.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n2-n48	E-UTRA Band 4, 5, 12, 13, 14, 17, 24, 25, 26, 29, 30, 41, 50, 51, 53, 66, 70, 71, 74, 85	F_{DL_low}	-	F_{DL_high}	-50	1

6.36.2.2 REFSENS requirements

Table 6.36.2.2-1 lists the MSD required due to 4th IMD for the dual uplink configuration.

Table 6.36.2.2-1: MSD due to IMD issue

CA Configuration	Operating band / Channel bandwidth / N _{RB} / Duplex mode							Source of IMD
	Operating band	UL F _c (MHz)	UL/DL BW (MHz)	UL C _{LRB}	DL F _c (MHz)	MSD (dB)	Duplex mode	
CA_n2A-n48A	n2	1852.5	5	25	1932.5	[12]	FDD	IMD4
CA_n2A-n48C	n48	3625	20	100	3625	N/A	TDD	N/A

6.37 CA_n28-n78

6.37.2 Specific for 2 bands UL CA

6.37.2.1 Channel bandwidths per operating band for CA

Table 6.37.2.1-1: Supported bandwidths per CA band combination of band n28+n78

CA operating / channel bandwidth														
NR CA Configuration	NR Uplink CA configuration	Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Maximum aggregated bandwidth [MHz]	Bandwidth combination set
CA_n28A-n78A	CA_n28A-n78A	n28	15	Yes	Yes	Yes	Yes						120	0
			30		Yes	Yes	Yes							
		n78	15		Yes	Yes	Yes	Yes	Yes					
			30		Yes									
			60		Yes									
CA_n28A-n78(2A)	CA_n28A-n78A	n28	15	Yes	Yes	Yes	Yes						220	0
			30		Yes	Yes	Yes							
		n78	See CA_n78(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1											

6.37.2.2 UE co-existence studies

Table 6.37.2.2-1 lists Band n28 + Band n78 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.37.2.2-1: Band n28 and Band n78 UL IMD products

UE UL carriers	Fx_low	Fx_high	Fy_low	Fy_high
UL frequency (MHz)	703	748	3300	3800
2nd order IMD products	fy_low - fx_high	fy_high - fx_low	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	2552	3097	4003	4548
Two-tone 3rd order IMD products	2*fx_low - fy_high	2*fx_high - fy_low	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	2394	1804	5852	6897
Two-tone 3rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	4706	5296	7303	8348
Two-tone 4th order IMD products	3*fx_low - 1*f_y_high	3*fx_high - 1*f_y_low	3*fy_low - 1*fx_high	3*fy_high - 1*fx_low
IMD frequency limits (MHz)	1691	1056	9152	10697
Two-tone 4th order IMD products	2*fx_low - 2*f_y_high	2*fx_high - 2*f_y_low		
IMD frequency limits (MHz)	5104	6194		
Two-tone 4th order IMD products	3*fx_low + 1*f_y_low	3*fx_high + 1*f_y_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high

IMD frequency limits (MHz)	5409	6044	10603	12148
Two-tone 4th order IMD products	$ 2*fx_low + 2*fy_low $	$ 2*fx_high + 2*fy_high $		
IMD frequency limits (MHz)	8006	9096		
Two-tone 5th order IMD products	$ fx_low - 4*fy_high $	$ fx_high - 4*fy_low $	$ fy_low - 4*fx_high $	$ fy_high - 4*fx_low $
IMD frequency limits (MHz)	14497	12452	308	988
Two-tone 5th order IMD products	$ 2*fx_low - 3*fy_high $	$ 2*fx_high - 3*fy_low $	$ 2*fy_low - 3*fx_high $	$ 2*fy_high - 3*fx_low $
IMD frequency limits (MHz)	9994	8404	4356	5491
Two-tone 5th order IMD products	$ fx_low + 4*fy_low $	$ fx_high + 4*fy_high $	$ fy_low + 4*fx_low $	$ fy_high + 4*fx_high $
IMD frequency limits (MHz)	13903	15948	6112	6792
Two-tone 5th order IMD products	$ 2*fx_low + 3*fy_low $	$ 2*fx_high + 3*fy_high $	$ 2*fy_low + 3*fx_low $	$ 2*fy_high + 3*fx_high $
IMD frequency limits (MHz)	11306	12896	8709	9844

Based on Table 6.37.2.2-1, the 5th IMD falls down own Rx frequencies of band n28.

Table 6.37.2.2-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.37.2.2-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n28-n78	E-UTRA Band 3, 5, 7, 8, 18, 19, 20, 26, 34, 39, 40, 41	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 65	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 1	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1
	Frequency range	758	-	773	-32	1
	Frequency range	773	-	803	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3
NOTE 1: Applicable when co-existence with PHS system operating in 1884.5 - 1915.7 MHz						
NOTE 2: Applicable when the assigned E-UTRA carrier is confined within 718 MHz and 748 MHz and when the channel bandwidth used is 5 or 10 MHz.						

6.37.2.3 REFSENS requirements

Table 6.37.2.3-1 lists the MSD required due to 5th IMD for the dual uplink configuration.

Table 6.37.2.3-1: MSD due to IMD issue

Operating band / Channel bandwidth / N _{RB} / Duplex mode								Source of IMD
CA Configuration	Operating band	UL F _c (MHz)	UL/DL BW (MHz)	UL C _{LRB}	DL F _c (MHz)	MSD (dB)	Duplex mode	
CA_n28A-n78 CA_n28A-n78(2A)	n28	705.5	5	25	760.5	5.5	FDD	IMD5
	n78	3582.5	10	50	3582.5	N/A	TDD	N/A

6.38 CA_n1-n8

6.38.1 Common for 1 band UL and 2 bands UL

6.38.1.1 Operating bands for CA

Table 6.38.1.1-1: CA band combination of band n1+n8

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
	BS receive / UE transmit			BS transmit / UE receive				
	F _{UL_low} – F _{UL_high}	F _{DL_low} – F _{DL_high}						
n1	1920 MHz – 1980 MHz	2110 MHz – 2170 MHz					FDD	
n8	880 MHz – 915 MHz	925 MHz – 960 MHz					FDD	

6.38.1.2 Channel bandwidths per operating band for CA

Table 6.38.1.2-1: Supported bandwidths per CA band combination of band n1+n8

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n1A-n8A	CA_n1A-n8A	n1	15	Ye s	Ye s	Ye s	Ye s									0
			30		Ye s	Ye s	Ye s									
			60		Ye s	Ye s	Ye s									
		n8	15	Ye s	Ye s	Ye s	Ye s									
			30		Ye s	Ye s	Ye s									
			60													

6.38.1.3 UE co-existence studies

Table 6.38.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n1-n8.

Table 6.38.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		nth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n1	1920	1980	2110	2170	3840	3960	5760	5940		
n8	880	915	925	960	1760	1830	2640	2745		

Based on above table, there is no harmonic issue for the band combination of n1 and n8.

Table 6.38.1.3-2: Impact of UL/DL Harmonic mixing

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2nd Harmonic		3rd Harmonic		mth Harmonic	
					DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n1	1920	1980	2110	2170	4220	4340	6330	6510		
n8	880	915	925	960	1850	1920	2775	2880		

Based on above table, there is no harmonic mixing issue for the band combination of n1 and n8.

6.38.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n1-n8, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values for UEs not supporting simultaneous Rx/Tx are given in the tables below.

Table 6.38.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n1-n8	n1	0.3
	n8	0.3

Table 6.38.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n1-n8	n1	0
	n8	0

6.38.1.5 REFSENS requirements

There are no specific REFSENS requirements

6.38.2 Specific for 2 bands UL CA

6.38.2.1 UE co-existence studies

Table 6.38.2.1-1 lists Band n1 + Band n8 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.38.2.1-1: Band n1 and Band n8 2UL bands IMD products

UE UL carriers	fx_low	fx_high	<bfy_low< b=""></bfy_low<>	fy_high
UL frequency (MHz)	1920	1980	880	915
2 nd order IMD products	fy_low - fx_high	fy_high - fx_low	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	1005 - 1100		2800 - 2895	
Two-tone 3 rd order IMD products	2*fx_low - fy_high	2*fx_high - fy_low	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	2925 - 3080		90 - 220	
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	4720 - 4875		3680 - 3810	
Two-tone 4 th order IMD products	3*fx_low - 1*fy_high	3*fx_high - 1*fy_low	3*fy_low - 1*fx_high	3*fy_high - 1*fx_low
IMD frequency limits (MHz)	4845 - 5060		660 - 825	
Two-tone 4 th order IMD products	2*fx_low - 2*fy_high	2*fx_high - 2*fy_low		
IMD frequency limits (MHz)	2010 - 2200			
Two-tone 4 th order IMD products	3*fx_low + 1*fy_low	3*fx_high + 1*fy_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high
IMD frequency limits (MHz)	6640 - 6855		4560 - 4725	
Two-tone 4 th order IMD products	2*fx_low + 2*fy_low	2*fx_high + 2*fy_high		
IMD frequency limits (MHz)	5600 - 5790			
Two-tone 5 th order IMD products	fx_low - 4*fy_high	fx_high - 4*fy_low	fy_low - 4*fx_high	fy_high - 4*fx_low
IMD frequency limits (MHz)	1540 - 1740		6765 - 7040	
Two-tone 5 th order IMD products	2*fx_low - 3*fy_high	2*fx_high - 3*fy_low	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)	1095 - 1320		3930 - 4180	
Two-tone 5 th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
IMD frequency limits (MHz)	5440 - 5640		8560 - 8835	
Two-tone 5 th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	6480 - 6705		7520 - 7770	

NOTE : For each IMD item, when two bound values before taking absolute have different signs, the relevant IMD range shall be set such that (1) the lower bound is 0 and (2) the upper bound is the bigger value of the two after taking absolute.

Based on the above table, IMD4 may fall into own Rx of band 1.

Table 6.38.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.38.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n1-n8	E-UTRA Band 20, 28, 31, 32, 38, 40, 45, 50, 51, 65, 67, 68, 69, 72, 73, 74, 75, 76	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 3, 7, 22, 41, 42, 43, NR Band n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 1, 8, 34	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3
	Frequency range	1880		1895	-40	1
	Frequency range	1895		1915	-15.5	5
	Frequency range	1915		1920	+1.6	5
NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2 \text{ MHz} + N \times L_{CRB} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.						
NOTE 3:	Applicable when co-existence with PHS system operating in 1884.5 -1915.7 MHz					
NOTE 4:	These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.					
NOTE 5:	This requirement is applicable only for the following cases: A: for carriers of 5 MHz channel bandwidth when carrier centre frequency (F_c) is within the range $902.5 \text{ MHz} \leq F_c < 907.5 \text{ MHz}$ with an uplink transmission bandwidth less than or equal to 20 RB; B: for carriers of 5 MHz channel bandwidth when carrier centre frequency (F_c) is within the range $907.5 \text{ MHz} \leq F_c \leq 912.5 \text{ MHz}$ without any restriction on uplink transmission bandwidth; D: for carriers of 10 MHz channel bandwidth when carrier centre frequency (F_c) is $F_c = 910 \text{ MHz}$ with an uplink transmission bandwidth less than or equal to 32 RB with $RBstart > 3$.					
NOTE 6:	This requirement is applicable for any channel bandwidths within the range 1920 - 1980 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 1927.5 - 1929.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 1930 - 1938 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB.					
NOTE 7:	For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.					

NOTE: All the tables mentioned in the note of above table are specified in TS38.101-1.

6.38.2.2 REFSENS requirements

Based on the coexistence studies for CA_n1-n8, there are 4th MSD issue need to be specified.

Table 6.38.2.2-1: MSD due to IMD issue

Operating band / Channel bandwidth / N _{RB} / Duplex mode								Source of IMD
CA Configuration	Operating band	UL F _c (MHz)	UL/DL BW (MHz)	UL L _{CRB}	DL F _c (MHz)	MSD (dB)	Duplex mode	
CA_n1A-n8A	n1	1965	5	25	2155	6.0	FDD	IMD4
	n8	887.5	5	25	932.5	N/A	FDD	N/A

6.39 CA_n66-n78

6.39.1 Common for 1 band UL and 2 bands UL CA

6.39.1.1 Operating bands for CA

Table 6.39.1-1: CA band combination of band n66 + n78

NR CA Band Combination	NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
		BS receive / UE transmit			BS transmit / UE receive				
		$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$				
CA_n66-n78	n66	1710 MHz – 1780 MHz		2110 MHz – 2200 MHz		FDD		TDD	
	n78	3300 MHz – 3800 MHz		3300 MHz – 3800 MHz					

6.39.1.2 Channel bandwidths per operating band for CA

Table 8.x.2-1: Supported bandwidths per CA band combination of band n7+n66

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n66A-n78A	CA_n66A-n78A	n66	15	Yes	Yes	Yes	Yes			Yes						0
			30		Yes	Yes	Yes			Yes						
			60		Yes	Yes	Yes			Yes						
		n78	15		Yes	Yes	Yes			Yes	Yes					0
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
CA_n66A-n78(2A)	CA_n66A-n78A	n66	15	Yes	Yes	Yes	Yes		Yes	Yes						0
			30		Yes	Yes	Yes		Yes	Yes						
			60		Yes	Yes	Yes		Yes	Yes						
		n78	See CA_n78(2A) Bandwidth Combination Set 1 in Table 5.5A.2-1													0
			n66	See CA_n66(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1												
CA_n66(2A)-n78A	CA_n66A-n78A	n78	15		Yes					0						
			30		Yes											
			60		Yes											
CA_n66(2A)-n78(2A)	CA_n66A-n78A	n66	See CA_n66(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1													0
		n78	See CA_n78(2A) Bandwidth Combination Set 1 in Table 5.5A.2-1													0

6.39.1.3 Co-existence studies

Table 6.39.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n66-n78.

Table 6.39.1.3-1: Impact of UL/DL Harmonic

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2nd Harmonic		3rd Harmonic		nth Harmonic	
					UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n66	1710	1780	2110	2200	3420	3560	5130	5340		
n78	3300	3800	3300	3800	6600	7600	9900	11400		

Based on above table, the 2nd harmonic of band n66 will fall into the RX band of n78.

Table 6.39.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic		3rd Harmonic		mth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n66	1710	1780	2110	2200	4220	4400	6330	6600		
n78	3300	3800	3300	3800	6600	7600	9900	11400		

Based on above table, there is no harmonics mixing issue for the band combination of n66 and n78.

6.39.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n66A-n78A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.39.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n66-n78	n66	0.6
	n78	0.8

Table 6.39.1.4-2: ΔR_{IB}

Inter-band CA Configuration	NR Band	ΔR_{IB} [dB]
CA_n66-n78	n66	0.2
	n78	0.5

6.39.1.5 REFSENs requirements

Based on Table 6.39.1.3-1, the 2nd harmonic of band n66 will fall into the RX band of n78. The MSD for DC_66A_n78A can be reused for the CA combination as shown in following tables.

Table 6.39.1.5-1: Reference sensitivity exceptions (MSD) due to UL harmonic

E-UTRA or NR Band / Channel bandwidth of the affected DL band / MSD													
UL band	DL band	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	30 MHz (dB)	40 MHz (dB)	50 MHz (dB)	60 MHz (dB)	80 MHz (dB)	90 MHz (dB)	100 MHz (dB)
n66	n78 ²		23.9	22.1	20.9			17.9	16.8	16.0	14.8	14.3	13.8
	n78 ³		1.1	0.8	0.3								

NOTE 2: The requirements should be verified for UL EARFCN or NR ARFCN of the aggressor (lower) band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.2 \rfloor_0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with carrier frequency in the victim (higher) band in MHz and the channel bandwidth configured in the lower band.

NOTE 3: The requirements are only applicable to channel bandwidths no larger than 20 MHz and with a carrier frequency at $\pm(20 + BW_{Channel}^{HB} / 2)$ MHz offset from $2f_{UL}^{LB}$ in the victim (higher band) with $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$, whereand $BW_{Channel}^{HB}$ are the channel bandwidths configured in the aggressor (lower) and victim (higher) bands in MHz, respectively.

Table 6.39.1.5-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic

NR Band / Channel bandwidth of the high band														
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	
n66	n78		25	36	50			100	100	100	100	100	100	

6.39.2 Specific for 2 bands UL CA

6.39.2.1 UE co-existence studies

Table 6.39.2.1-1 gives IMD interference analysis for CA_n66-n78 with 2 ULs.

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	3300	3800	1710	1780
Two tone 2 nd order IMD products	$ f_y_{low} - f_x_{high} $	$ f_y_{high} - f_x_{low} $	$f_x_{low} + f_y_{low}$	$f_x_{high} + f_y_{high}$
IMD frequency limits (MHz)	2090	1520	5010	5580
Two-tone 3 rd order IMD products	$ 2*f_x_{low} - f_y_{high} $	$ 2*f_x_{high} - f_y_{low} $	$2*f_y_{low} - f_x_{high}$	$2*f_y_{high} - f_x_{low}$
IMD frequency limits (MHz)	4820	5890	380	260
Two-tone 3 rd order IMD products	$2*f_x_{low} + f_y_{low}$	$2*f_x_{high} + f_y_{high}$	$2*f_y_{low} + f_x_{low}$	$2*f_y_{high} + f_x_{high}$
IMD frequency limits (MHz)	8310	9380	6720	7360
Two-tone 4 th order IMD products	$ 3*f_x_{low} - f_y_{high} $	$ 3*f_x_{high} - f_y_{low} $	$3*f_y_{low} - f_x_{high}$	$3*f_y_{high} - f_x_{low}$
IMD frequency limits (MHz)	8120	9690	1330	2040
Two-tone 4 th order IMD products	$3*f_x_{low} + f_y_{low}$	$3*f_x_{high} + f_y_{high}$	$3*f_y_{low} + f_x_{low}$	$3*f_y_{high} + f_x_{high}$
IMD frequency limits (MHz)	11610	13180	8430	8640
Two-tone 4 th order IMD products	$2*f_y_{low} - 2*f_x_{high}$	$2*f_y_{high} - 2*f_x_{low}$	$2*f_x_{low} + 2*f_y_{low}$	$2*f_x_{high} + 2*f_y_{high}$
IMD frequency limits (MHz)	4180	3040	10020	11160
Two-tone 5 th order IMD products	$ 4*f_x_{low} - f_y_{high} $	$ 4*f_x_{high} - f_y_{low} $	$4*f_y_{low} - f_x_{high}$	$4*f_y_{high} - f_x_{low}$
IMD frequency limits (MHz)	11420	13490	3040	3820
Two-tone 5 th order IMD products	$4*f_x_{low} + f_y_{low}$	$4*f_x_{high} + f_y_{high}$	$4*f_y_{low} + f_x_{low}$	$4*f_y_{high} + f_x_{high}$
IMD frequency limits (MHz)	14910	16980	10140	10920
Two-tone 5 th order IMD products	$ 3*f_x_{low} - 2*f_y_{high} $	$ 3*f_x_{high} - 2*f_y_{low} $	$3*f_y_{low} - 2*f_x_{high}$	$3*f_y_{high} - 2*f_x_{low}$
IMD frequency limits (MHz)	6340	7980	2470	1260
Two-tone 5 th order IMD products	$2*f_x_{low} + 3*f_y_{low}$	$2*f_x_{high} + 3*f_y_{high}$	$2*f_y_{low} + 3*f_x_{low}$	$2*f_y_{high} + 3*f_x_{high}$
IMD frequency limits (MHz)	11730	12940	13320	14960

Based on above table, the following cases may have IMD products fall into the own TX

- two-tone 4th order and two-tone 5th order IMD products may fall into the own Rx Band of Band n78
- two-tone 5th order IMD products may fall into the own Rx Band of Band n66

Table 6.39.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.39.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n66-n78	E-UTRA Band 2, 4, 5, 7, 12, 13, 14, 17, 29, 26, 28, 41, 66, 71	FDL_low	-	FDL_high	-50	1

6.39.2.2 REFSENS requirements

Based on above coexistence study, two-tone 4th order and two-tone 5th order IMD products may fall into the own Rx Band of Band n78, and two-tone 5th order IMD products may fall into the own Rx Band of Band n66. n78 is a TDD band hence there is no issue for the case IMD products fall into RX of band n78. The IMD5 case is similar as CA_n48A-n66A. The MSD

Table 6.39.2.2-1: 2DL/2UL interband Reference sensitivity QPSK $P_{REFSENS}$ and uplink/downlink configurations

Band / Channel bandwidth / N_{RB} / Duplex mode							Source of IMD	
NR CA Configuration	NR band	UL F_c (MHz)	UL/DL BW (MHz)	UL C_{LRB}	DL F_c (MHz)	MSD (dB)	Duplex mode	
CA_n66A-n78A	n66	1730	5	25	2130	5.0	FDD	IMD5
CA_n66A-n78(2A)		3660	10	50	3660	N/A	TDD	N/A
CA_n66(2A)-n78A	n78							
CA_n66(2A)-n78(2A)								

6.40 CA_n39-n40

6.40.1 Common for 1 band UL and 2 bands UL CA

6.40.1.1 Operating bands for CA

Table 6.40.1.1-1: CA band combination of band n39+n40

NR CA Band	NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
		BS receive / UE transmit		BS transmit / UE receive			
		F_{UL_low} – F_{UL_high}	F_{DL_low} – F_{DL_high}	F_{DL_low} – F_{DL_high}	F_{DL_low} – F_{DL_high}		
CA_n39-n40	n39	1880 MHz – 1920 MHz		1880 MHz – 1920 MHz		TDD	
	n40	2300MHz – 2400 MHz		2300 MHz – 2400 MHz		TDD	

6.40.1.2 Channel bandwidths per operating band for CA

Table 6.40.2-1: Supported bandwidths per CA band combination of band n39+n40

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Bandwidth combination set
CA_n39A-n40A	CA_n39A-n40A	n39	15	Ye s						0						
			30		Ye s	Ye s	Ye s	Ye s	Ye s	Ye s						
			60		Ye s	Ye s	Ye s	Ye s	Ye s	Ye s						
		n40	15	Ye s												
			30		Ye s											
			60		Ye s											

6.40.1.3 Co-existence studies

Table 6.40.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n39-n40.

Table 6.40.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		nth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n39	1880	1920	1880	1920	3760	3840	5640	5760		
n40	2300	2400	2300	2400	4600	4800	6900	7200		

Based on above table, there is no harmonic issue for the band combination of n39 and n40.

Table 6.40.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic		3rd Harmonic		mth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n39	1880	1920	1880	1920	3760	3840	5640	5760		
n40	2300	2400	2300	2400	4600	4800	6900	7200		

Based on above table, there is no harmonic mixing issue for the band combination of n39 and n40.

6.40.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n39-n40, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below, and they are same with ENDC combination DC_39A_n40A.

Table 6.40.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n39-n40	n39	0
	n40	0

NOTE 1: Applicable for UE supporting inter-band CA without simultaneous Rx/Tx.

Table 6.40.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n39-n40	n39	0.3
	n40	0.3
NOTE 1: Applicable for UE supporting inter-band CA without simultaneous Rx/Tx.		

6.40.1.5 REFSEN requirements

For single uplink operation of this combination, only harmonic issue need to be considered. As shown in co-existence study in section 6.40.1.3, there are no harmonic issues for CA_n39-n40. Hence there are no specific REFSENS requirements.

6.40.2 Specific for 2 bands UL CA

6.40.2.1 UE co-existence studies

Table 6.40.2.1-1 lists Band n39 +Band n40 2UL CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.40.2.1-1: Band n39 and Band n40 UL IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency	1880	1920	2300	2400
2 nd order IMD products	$ fy_{low} - fx_{high} $	$ fy_{high} - fx_{low} $	$ fy_{low} + fx_{low} $	$ fy_{high} + fx_{high} $
IMD frequency limits (MHz)	380	520	4180	4320
Two-tone 3 rd order IMD products	$ fy_{high} - 2*fx_{low} $	$ fy_{low} - 2*fx_{high} $	$ 2*fy_{low} - fx_{high} $	$ 2*fy_{high} - fx_{low} $
IMD frequency limits (MHz)	1360	1540	2680	2920
Two-tone 3 rd order IMD products	$ 2*fx_{low} + fy_{low} $	$ 2*fx_{high} + fy_{high} $	$ 2*fy_{low} + fx_{low} $	$ 2*fy_{high} + fx_{high} $
IMD frequency limits (MHz)	6060	6240	6480	6720
Two-tone 3 rd order IMD products	$(fx_{low} - \text{max BW } fy)$	$(fx_{high} + \text{max BW } fy)$	$(fy_{low} - \text{max BW } fx)$	$(fy_{high} + \text{max BW } fx)$
IMD frequency limits (MHz)	1860	1940	2280	2420
Two-tone 4 th order IMD products	$ 2*fx_{low} - 2*fy_{high} $	$ 2*fx_{high} - 2*fy_{low} $	$ 2*fx_{low} + 2*fy_{low} $	$ 2*fx_{high} + 2*fy_{high} $
IMD frequency limits (MHz)	1040	760	8360	8640
Two-tone 4 th order IMD products	$ 3*fx_{low} - 1*fy_{high} $	$ 3*fx_{high} - 1*fy_{low} $	$ 3*fy_{low} - 1*fx_{high} $	$ 3*fy_{high} - 1*fx_{low} $
IMD frequency limits (MHz)	3240	3460	4980	5320
Two-tone 4 th order IMD products	$ 3*fx_{low} + 1*fy_{low} $	$ 3*fx_{high} + 1*fy_{high} $	$ 3*fy_{low} + 1*fx_{low} $	$ 3*fy_{high} + 1*fx_{high} $
IMD frequency limits (MHz)	7940	8160	8780	9120
Two-tone 5 th order IMD products	$ fx_{low} - 4*fy_{high} $	$ fx_{high} - 4*fy_{low} $	$ fy_{low} - 4*fx_{high} $	$ fy_{high} - 4*fx_{low} $
IMD frequency limits (MHz)	7720	7280	5380	5120
Two-tone 5 th order IMD products	$ fx_{low} + 4*fy_{low} $	$ fx_{high} + 4*fy_{high} $	$ fy_{low} + 4*fx_{low} $	$ fy_{high} + 4*fx_{high} $
IMD frequency limits (MHz)	11080	11520	9820	10080
Two-tone 5 th order IMD products	$ 2*fx_{low} - 3*fy_{high} $	$ 2*fx_{high} - 3*fy_{low} $	$ 2*fy_{low} - 3*fx_{high} $	$ 2*fy_{high} - 3*fx_{low} $
IMD frequency limits (MHz)	3440	3060	1160	840
Two-tone 5 th order IMD products	$ 2*fx_{low} + 3*fy_{low} $	$ 2*fx_{high} + 3*fy_{high} $	$ 2*fy_{low} + 3*fx_{low} $	$ 2*fy_{high} + 3*fx_{high} $
IMD frequency limits (MHz)	10660	11040	10240	10560

NOTE : For each IMD item, when two bound values before taking absolute have different signs, the relevant IMD range shall be set such that (1) the lower bound is 0 and (2) the upper bound is the bigger value of the two after taking absolute.

Based on Table 6.40.2.1-1:

- There are no IMD will fall into own Rx of band n39 and band n40.

It shall be noted that the table 6.40.2.1-1 does not calculate the 3rd order IMD frequency range of “fx_low – max BW fy” to “fx_low + max BW fy” which may fall into own Rx band. However, the MSD caused by this IM3 should not be specified due to lower PSD of NR transmission. In addition, it is TDD-TDD band CA combination, which means the Tx and Rx will not be supported at the same time for a certain TDD band, thus it is no need to consider the IMD influence.

Table 6.40.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.40.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n39A-n40A	E-UTRA Band 1, 8, 22, 26, 34, 41, 42, 44, 45, 50, 51, 52, 73, 74	F _{DL_low}	-	F _{DL_high}	-50	1
	NR Band n77, n78, n79	F _{DL_low}	-	F _{DL_high}	-50	1
	Frequency range	1805	1855	-40	1	8
	Frequency range	1855	1880	-15.5	5	4, 7, 8

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, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of (2MHz + N x L_{CRB} x 180kHz), where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.

NOTE 4: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.6.3.1-1 and Table 6.6.3.1A-1 from the edge of the channel bandwidth.

NOTE 7: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.

NOTE 8: This requirement is only applicable for E-UTRA carriers with bandwidth confined within 1885 - 1920 MHz (requirement for carriers with at least 1RB confined within 1880 - 1885 MHz is not specified). This requirement applies for an uplink transmission bandwidth less than or equal to 54 RB for E-UTRA carriers of 15 MHz bandwidth when carrier center frequency is within the range 1892.5 - 1894.5 MHz and for E-UTRA carriers of 20 MHz bandwidth when carrier center frequency is within the range 1895 - 1903 MHz.

NOTE: All the tables mentioned in the note of above table are specified in TS38.101-1.

6.40.2.2 REFSENS requirements

According to the co-existence analysis in table 6.40.2.1-1, there are no IMD issues are expected for this CA configuration with dual uplink carrier.

6.41 CA_n3-n40

6.41.1 Common for 1 band UL and 2 bands UL CA

6.41.1.1 Operating bands for CA

Table 6.41.1.1-1: CA band combination of band n3+n40

NR CA Band	NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
		BS receive / UE transmit		BS transmit / UE receive			
		F _{UL_low} – F _{UL_high}	F _{DL_low} – F _{DL_high}	F _{DL_low} – F _{DL_high}	F _{DL_low} – F _{DL_high}		
CA_n3-n40	n3	1710 MHz – 1785 MHz	1805 MHz – 1880 MHz	1805 MHz – 1880 MHz	1805 MHz – 1880 MHz	TDD	
	n40	2300MHz – 2400 MHz	2300 MHz – 2400 MHz	2300 MHz – 2400 MHz	2300 MHz – 2400 MHz	TDD	

6.41.1.2 Channel bandwidths per operating band for CA

Table 6.41.2-1: Supported bandwidths per CA band combination of band n3+n40

		CA operating / channel bandwidth [MHz]															Bandwidth combination set
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz		
CA_n3A-n40A	CA_n3A-n40A	n3	15	Ye s	Ye s	Ye s	Ye s	Ye s	Ye s								0
			30		Ye s												
			60		Ye s												
		n40	15	Ye s	Ye s	Ye s	Ye s	Ye s	Ye s	Ye s	Ye s						
			30		Ye s												
			60		Ye s												

6.41.1.3 Co-existence studies

Table 6.41.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n3-n40.

Table 6.41.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		nth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n3	1710	1785	1805	1880	3420	3570	4992	5380		
n40	2300	2400	2300	2400	4600	4800	6900	7200		

Based on above table, there is no harmonic issue for the band combination of n3 and n40.

Table 6.41.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic		3rd Harmonic		mth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n3	1710	1785	1805	1880	3610	3760	5415	5640		
n40	2300	2400	2300	2400	4600	4800	6900	7200		

Based on above table, there is no harmonic mixing issue for the band combination of n3 and n40.

6.41.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n3-n40, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below, and they are same with ENDC combination DC_3A_n40A.

Table 6.41.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n3-n40	n3	0.5
	n40	0.5

Table 6.41.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n3-n40	n3	0
	n40	0

6.41.1.5 REFSEN requirements

For single uplink operation of this combination, only harmonic issue need to be considered. As shown in co-existence study in section 6.41.1.3, there are no harmonic issues for CA_n3-n40. Hence there are no specific REFSENS requirements.

6.41.2 Specific for 2 bands UL CA

6.41.2.1 UE co-existence studies

Table 6.41.2.1-1 lists Band n3 +Band n40 2UL CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.41.2.1-1: Band n3 and Band n40 UL IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	1710	1785	2300	2400
2nd order IMD products	$ fy_{high} - fx_{low} $	$ fy_{low} - fx_{high} $	$ fy_{low} + fx_{low} $	$ fy_{high} + fx_{high} $
IMD frequency limits (MHz)	690	515	4010	4185
3rd order IMD products	$ fy_{high} - 2*fx_{low} $	$ fy_{low} - 2*fx_{high} $	$ 2*fy_{low} - fx_{high} $	$ 2*fy_{high} - fx_{low} $
IMD frequency limits (MHz)	1020	1270	2815	3090
3rd order IMD products	$ 2*fx_{low} + fy_{low} $	$ 2*fx_{high} + fy_{high} $	$ 2*fy_{low} + fx_{low} $	$ 2*fy_{high} + fx_{high} $
IMD frequency limits (MHz)	5720	5970	6310	6585
Two-tone 4th order IMD products	$ 2*fx_{low} - 2*fy_{high} $	$ 2*fx_{high} - 2*fy_{low} $	$ 2*fx_{low} + 2*fy_{low} $	$ 2*fx_{high} + 2*fy_{high} $
IMD frequency limits (MHz)	1380	1030	8020	8370
Two-tone 4th order IMD products	$ 3*fx_{low} - 1*fy_{high} $	$ 3*fx_{high} - 1*fy_{low} $	$ 3*fy_{low} - 1*fx_{high} $	$ 3*fy_{high} - 1*fx_{low} $
IMD frequency limits (MHz)	2730	3055	5115	5490
Two-tone 4th order IMD products	$ 3*fx_{low} + 1*fy_{low} $	$ 3*fx_{high} + 1*fy_{high} $	$ 3*fy_{low} + 1*fx_{low} $	$ 3*fy_{high} + 1*fx_{high} $
IMD frequency limits (MHz)	7430	7755	8610	8985
Two-tone 5th order IMD products	$ fx_{low} - 4*fy_{high} $	$ fx_{high} - 4*fy_{low} $	$ fy_{low} - 4*fx_{high} $	$ fy_{high} - 4*fx_{low} $
IMD frequency limits (MHz)	7890	7415	4840	4440
Two-tone 5th order IMD products	$ fx_{low} + 4*fy_{low} $	$ fx_{high} + 4*fy_{high} $	$ fy_{low} + 4*fx_{low} $	$ fy_{high} + 4*fx_{high} $
IMD frequency limits (MHz)	10910	11385	9140	9540
Two-tone 5th order IMD products	$ 2*fx_{low} - 3*fy_{high} $	$ 2*fx_{high} - 3*fy_{low} $	$ 2*fy_{low} - 3*fx_{high} $	$ 2*fy_{high} - 3*fx_{low} $
IMD frequency limits (MHz)	3780	3330	755	330
Two-tone 5th order IMD products	$ 2*fx_{low} + 3*fy_{low} $	$ 2*fx_{high} + 3*fy_{high} $	$ 2*fy_{low} + 3*fx_{low} $	$ 2*fy_{high} + 3*fx_{high} $
IMD frequency limits (MHz)	10320	10770	9730	10155

NOTE : For each IMD item, when two bound values before taking absolute have different signs, the relevant IMD range shall be set such that (1) the lower bound is 0 and (2) the upper bound is the bigger value of the two after taking absolute.

Based on Table 6.41.2.1-1:

- There are no IMD will fall into own Rx of band n3 and band n40.

It shall be noted that the table 6.41.2.1-1 does not calculate the 3rd order IMD frequency range of “fx_low – max BW fy” to “fx_low + max BW fy” which may fall into own Rx band. However, the MSD caused by this IM3 should not be specified due to lower PSD of NR transmission.

Table 6.41.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.41.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n3A-n40A	E-UTRA Band 1, 5, 7, 8, 20, 26, 27, 28, 31, 32, 33, 34, 38, 39, 41, 43, 44, 45, 50, 51, 65, 67, 68, 69, 72, 73, 75, 76	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 3	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 22, 42, 52 NR Band n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3
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 2 nd , 3 rd , 4 th or 5 th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2\text{MHz} + N \times L_{CRB} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2 nd , 3 rd , 4 th or 5 th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.						
NOTE 4: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.6.3.1-1 and Table 6.6.3.1A-1 from the edge of the channel bandwidth.						
NOTE 13: This requirement applies for 5, 10, 15 and 20 MHz E-UTRA channel bandwidth allocated within 1744.9MHz and 1784.9MHz.						

NOTE: All the tables mentioned in the note of above table are specified in TS38.101-1.

6.41.2.2 REFSENS requirements

According to the co-existence analysis in table 6.41.2.1-1, there are no IMD issues expected for this CA configuration with dual uplink carrier.

6.42 CA_n8-n40

6.42.1 Common for 1 band UL and 2 bands UL CA

6.42.1.1 Operating bands for CA

Table 6.42.1.1-1: CA band combination of band n8+n40

NR CA Band	NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
		BS receive / UE transmit		BS transmit / UE receive			
		F_{UL_low} – F_{UL_high}	F_{DL_low} – F_{DL_high}	F_{DL_low} – F_{DL_high}	F_{DL_low} – F_{DL_high}		
CA_n8-n40	n8	880 MHz – 915 MHz	925 MHz – 960 MHz	925 MHz – 960 MHz	925 MHz – 960 MHz	FDD	
	n40	2300MHz – 2400 MHz	2300 MHz – 2400 MHz	2300 MHz – 2400 MHz	2300 MHz – 2400 MHz	TDD	

6.42.1.2 Channel bandwidths per operating band for CA

Table 6.42.2-1: Supported bandwidths per CA band combination of band n8+n40

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5M Hz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Bandwidth combination set
CA_n8A-n40A	CA_n8A-n40A	n8	15	Ye s	Ye s	Ye s	Ye s									0
			30		Ye s	Ye s	Ye s									
			60													
		n40	15	Ye s												
			30		Ye s											
			60		Ye s											

6.42.1.3 Co-existence studies

Table 6.42.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n8-n40.

Table 6.42.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		nth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n8	880	915	925	960	1760	1830	2640	2745		
n40	2300	2400	2300	2400	4600	4800	6900	7200		

Based on above table, there is no harmonic issue for the band combination of n8 and n40.

Table 6.42.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic		3rd Harmonic		mth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n8	880	915	925	960	1850	1920	2775	2880		
n40	2300	2400	2300	2400	4600	4800	6900	7200		

Based on above table, there is no harmonic mixing issue for the band combination of n8 and n40.

6.42.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n8-n40, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below, and they are reused from ENDC combination DC_8A_n40A in TR37.863-01-01.

Table 6.42.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n8-n40	n8	0.3
	n40	0.3

Table 6.42.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,C}$ [dB]
CA_n8-n40	n8	0
	n40	0

6.42.1.5 REFSEN requirements

For single uplink operation of this combination, only harmonic issue need to be considered. As shown in co-existence study in section 6.42.1.3, there are no harmonic issues for CA_n8-n40. Hence there are no specific REFSENS requirements.

6.42.2 Specific for 2 bands UL CA

6.42.2.1 UE co-existence studies

Table 6.42.2.1-1 lists Band n8 + Band n40 2UL CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.42.2.1-1: Band n8 and Band n40 UL IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	880	915	2300	2400
2nd order IMD products	$ fy_{high} - fx_{low} $	$ fy_{low} - fx_{high} $	$ fy_{low} + fx_{low} $	$ fy_{high} + fx_{high} $
IMD frequency limits (MHz)	1520	1385	3180	3315
3rd order IMD products	$ fy_{high} - 2*fx_{low} $	$ fy_{low} - 2*fx_{high} $	$ 2*fy_{low} - fx_{high} $	$ 2*fy_{high} - fx_{low} $
IMD frequency limits (MHz)	640	470	3685	3920
3rd order IMD products	$ 2*fx_{low} + fy_{low} $	$ 2*fx_{high} + fy_{high} $	$ 2*fy_{low} + fx_{low} $	$ 2*fy_{high} + fx_{high} $
IMD frequency limits (MHz)	4060	4230	5480	5715
Two-tone 4th order IMD products	$ 2*fx_{low} - 2*fy_{high} $	$ 2*fx_{high} - 2*fy_{low} $	$ 2*fx_{low} + 2*fy_{low} $	$ 2*fx_{high} + 2*fy_{high} $
IMD frequency limits (MHz)	3040	2770	6360	6630
Two-tone 4th order IMD products	$ 3*fx_{low} - 1*fy_{high} $	$ 3*fx_{high} - 1*fy_{low} $	$ 3*fy_{low} - 1*fx_{high} $	$ 3*fy_{high} - 1*fx_{low} $
IMD frequency limits (MHz)	240	445	5985	6320
Two-tone 4th order IMD products	$ 3*fx_{low} + 1*fy_{low} $	$ 3*fx_{high} + 1*fy_{high} $	$ 3*fy_{low} + 1*fx_{low} $	$ 3*fy_{high} + 1*fx_{high} $
IMD frequency limits (MHz)	4940	5145	7780	8115
Two-tone 5th order IMD products	$ fx_{low} - 4*fy_{high} $	$ fx_{high} - 4*fy_{low} $	$ fy_{low} - 4*fx_{high} $	$ fy_{high} - 4*fx_{low} $
IMD frequency limits (MHz)	8720	8285	1360	1120
Two-tone 5th order IMD products	$ fx_{low} + 4*fy_{low} $	$ fx_{high} + 4*fy_{high} $	$ fy_{low} + 4*fx_{low} $	$ fy_{high} + 4*fx_{high} $
IMD frequency limits (MHz)	10080	10515	5820	6060
Two-tone 5th order IMD products	$ 2*fx_{low} - 3*fy_{high} $	$ 2*fx_{high} - 3*fy_{low} $	$ 2*fy_{low} - 3*fx_{high} $	$ 2*fy_{high} - 3*fx_{low} $
IMD frequency limits (MHz)	5440	5070	1855	2160
Two-tone 5th order IMD products	$ 2*fx_{low} + 3*fy_{low} $	$ 2*fx_{high} + 3*fy_{high} $	$ 2*fy_{low} + 3*fx_{low} $	$ 2*fy_{high} + 3*fx_{high} $
IMD frequency limits (MHz)	8660	9030	7240	7545

Based on Table 6.42.2.1-1:

- There are no IMD will fall into own Rx of band n8 and band n40 .

It shall be noted that the table 6.42.2.1-1 does not calculate the 3rd order IMD frequency range of “fx_low – max BW fy” to “fx_low + max BW fy” which may fall into own Rx band. However, the MSD caused by this IM3 should not be specified due to lower PSD of NR transmission.

Table 6.42.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.42.2.1-2: Protected bands for the 2UL bands CA configuration

NR Configuration	CA	Spurious emission					
		Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n8A-n40A	E-UTRA Bands 1, 20, 28, 31, 32, 33, 34, 38, 39, 45, 50, 51, 65, 67, 68, 69, 72, 73, 74, 75, 76	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Bands 3, 7, 22, 41, 42, 43, 52 NR Bands n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1	2
	Band 8	F_{DL_low}	-	F_{DL_high}	-50	1	4
	Frequency range	860	-	890	-40	1	4, 5
		Frequency range	1884.5	-	1915.7	-41	0.3
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 2 nd , 3 rd , 4 th [or 5 th] harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2\text{MHz} + N \times L_{CRB} \times 180\text{kHz})$, where N is 2, 3, 4, [5] for the 2 nd , 3 rd , 4 th [or 5 th] harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.							
NOTE 3: Applicable when co-existence with PHS system operating in 1884.5 -1915.7MHz.							
NOTE 4: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.							
NOTE 5: This requirement is applicable only for the following cases: - for carriers of 5 MHz channel bandwidth when carrier centre frequency (F_c) is within the range $902.5 \text{ MHz} \leq F_c < 907.5 \text{ MHz}$ with an uplink transmission bandwidth less than or equal to 20 RB - for carriers of 5 MHz channel bandwidth when carrier centre frequency (F_c) is within the range $907.5 \text{ MHz} \leq F_c \leq 912.5 \text{ MHz}$ without any restriction on uplink transmission bandwidth. - for carriers of 10 MHz channel bandwidth when carrier centre frequency (F_c) is $F_c = 910 \text{ MHz}$ with an uplink transmission bandwidth less than or equal to 32 RB with $RB_{start} > 3$.							

NOTE: All the tables mentioned in the note of above table are specified in TS38.101-1.

6.42.2.2 REFSENS requirements

According to the co-existence analysis in table 6.42.2.1-1, there are no IMD issues are expected for this CA configuration

6.43 CA_n1-n3

6.43.1 Common for 1 band UL and 2 bands UL CA

6.43.1.1 Operating bands for CA

Table 6.43.1.1-1: CA band combination of band n1 + n3

NR CA Band Combination	NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
		BS receive / UE transmit		BS transmit / UE receive			
		$F_{UL_low} - F_{UL_high}$		$F_{DL_low} - F_{DL_high}$			
CA_n1-n3	n1	1920 MHz – 1980 MHz		2110 MHz – 2170 MHz		FDD	
	n3	1710 MHz – 1785 MHz		1805 MHz – 1880 MHz			

6.43.1.2 Channel bandwidths per operating band for CA

Table 6.43.1.2-1: Supported bandwidths per CA band combination of band n1+n3

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n1A-n3A	CA_n1A-n3A	n1	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
		n3	15	Yes	Yes	Yes	Yes	Yes	Yes							
			30		Yes	Yes	Yes	Yes	Yes	Yes						
			60		Yes	Yes	Yes	Yes	Yes	Yes						
CA_n1B-n3A	CA_n1A-n3A	n1	See CA_n1B Bandwidth Combination Set 0 in Table 5.5A.1-1 from 38.101-1													0
		n3	15	Yes	Yes	Yes	Yes	Yes	Yes							
			30		Yes	Yes	Yes	Yes	Yes	Yes						
			60		Yes	Yes	Yes	Yes	Yes	Yes						
CA_n1A-n3(2A)	CA_n1A-n3A	n1	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
		n3	See CA_n3(2A) bandwidth combination set in Table 5.5A.1-2 from 38.101-1													

6.43.1.3 Co-existence studies

Table 6.43.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n1-n3.

Table 6.43.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		4th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n1	1920	1980	2110	2170	3840	3960	5760	5940	7680	7920
n3	1710	1785	1805	1880	3420	3570	5130	5355	6840	7140

Based on above table, there is no harmonics issue for the band combination of n1 and n3.

Table 6.43.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic			3rd Harmonic		m th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge
n1	1920	1980	2110	2170	4220	4340	6330	6510			
n3	1710	1785	1805	1880	3610	3760	5415	5640			

Based on above table, there is no harmonics mixing issue for the band combination of n1 and n3.

6.43.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n1-n3, the $\Delta T_{IB,c}$ and ΔR_{IB} can follow the values of DC_1_n3. The values are given in the tables below.

Table 6.43.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n1-n3	n1	0.3
	n3	0.3

Table 6.43.1.4-2: ΔR_{IB}

Inter-band CA Configuration	NR Band	ΔR_{IB} [dB]
CA_n1-n3	n1	0
	n3	0

6.43.1.5 REFSENs requirements

There is reference sensitivity exception due to cross band isolation for CA_n1-n3 with single uplink, referring to DC_1_n3 or DC_3_n1

Table 6.43.1.5-1: MSD for the CA configuration for asynchronous operation and cross band isolation for CA

NR Band / Channel bandwidth of the affected DL band														
NR CA Configuration	UL band	DL band	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	30 MHz (dB)	40 MHz (dB)	50 MHz (dB)	60 MHz (dB)	80 MHz (dB)	90 MHz (dB)	100 MHz (dB)
CA_n1A-n3A CA_n1B-n3A CA_n1A-n3(2A)	n1	n3	3	2.2	1.9	1.7	1.6	1.5						

NOTE 1: Applicable only when harmonic mixing MSD for this combination is not applied.
 NOTE 2: Void

Table 6.43.1.5-2: Uplink configuration for reference sensitivity exceptions due to cross band isolation for CA

NR Band / SCS / Channel bandwidth of the affected DL band														
UL band	DL band	SCS of UL band (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n1	n3	15	25	25	25	25	25	25						

NOTE 1: The UL configuration applies regardless of the channel bandwidth of the UL band unless the UL resource blocks exceed that specified in Table 7.3.2-3 for the uplink bandwidth in which case the allocation according to Table 7.3.2-3 applies.
 NOTE 2: Refers to 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 in Table 5.3.2-1.

6.43.2 Specific for 2 bands UL CA

6.43.2.1 UE co-existence studies

Table 6.43.2.1-1 gives IMD interference analysis for CA_n1-n3 with 2 ULs.

UE UL carriers	fx_low	fx_high	fy_low	fy_high
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UL frequency (MHz)	1920	1980	1710	1785
2 nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2 nd harmonics frequency limits (MHz)	3840	3960	3420	3570
3 rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3 rd harmonics frequency limits (MHz)	5760	5940	5130	5355
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	7680	7920	6840	7140
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	9600	9900	8550	8925
2 nd order IMD products	fy_low - fx_high	fy_high - fx_low	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	270	135	3630	3765
Two-tone 3 rd order IMD products	2*fx_low - fy_high	2*fx_high - fy_low	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	2055	2250	1440	1650
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	5550	5745	5340	5550
Two-tone 4 th order IMD products	3*fx_low - 1*fy_high	3*fx_high - 1*fy_low	3*fy_low - 1*fx_high	3*fy_high - 1*fx_low
IMD frequency limits (MHz)	3975	4230	3150	3435
Two-tone 4 th order IMD products	3*fx_low + 1*fy_low	3*fx_high + 1*fy_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high
IMD frequency limits (MHz)	7470	7725	7050	7335
Two-tone 4 th order IMD products	2*fx_low - 2*fy_high	2*fx_high - 2*fy_low	2*fx_low + 2*fy_low	2*fx_high + 2*fy_high
IMD frequency limits (MHz)	270	540	7260	7530
Two-tone 5 th order IMD products	fx_low - 4*fy_high	fx_high - 4*fy_low	fy_low - 4*fx_high	fy_high - 4*fx_low
IMD frequency limits (MHz)	5220	4860	6210	5895
Two-tone 5 th order IMD products	2*fx_low - 3*fy_high	2*fx_high - 3*fy_low	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)	1515	1170	2520	2190

Two-tone 5 th order IMD products	$ fx_{low} + 4*fy_{low} $	$ fx_{high} + 4*fy_{high} $	$ fy_{low} + 4*fx_{low} $	$ fy_{high} + 4*fx_{high} $
IMD frequency limits (MHz)	8760	9120	9390	9705
Two-tone 5 th order IMD products	$ 2*fx_{low} + 3*fy_{low} $	$ 2*fx_{high} + 3*fy_{high} $	$ 2*fy_{low} + 3*fx_{low} $	$ 2*fy_{high} + 3*fx_{high} $
IMD frequency limits (MHz)	8970	9315	9180	9510

Based on above table, the 3rd order IMD may fall into Rx frequencies of Band n1.

Table 6.43.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.43.2.1-2: Protected bands for the 2UL bands CA configuration

6.43.2.2 REFSENS requirements

Because of 3rd IMD issue, the MSD requirements are shown below referring to DC_1_n3 or DC_3_n1.

Table 6.43.2.2-1: 2DL/2UL interband Reference sensitivity QPSK $P_{REFSENS}$ and uplink/downlink configurations

Band / Channel bandwidth / N_{RB} / Duplex mode								Source of IMD
NR CA Configuration	NR band	UL F_c (MHz)	UL/DL BW (MHz)	UL C_{LRB}	DL F_c (MHz)	MSD (dB)	Duplex mode	
CA_n1A-n3A CA_n1B-n3A CA_n1A-n3(2A)	n1	1950	5	25	2140	[23]	FDD	IMD3
	n3	1760	5	25	1855	N/A	TDD	N/A

6.44 CA_n1-n41

6.44.1 Common for 1 band UL and 2 bands UL CA

6.44.1.1 Operating bands for CA

Table 6.44.1.1-1: CA band combination of band n1 + n41

NR CA Band Combination	NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode
		BS receive / UE transmit		$F_{UL_low} - F_{UL_high}$	BS transmit / UE receive		$F_{DL_low} - F_{DL_high}$	
		1920 MHz	–	1980 MHz	2110 MHz	–	2170 MHz	
CA_n1-n41	n1	2496 MHz	–	2690 MHz	2496 MHz	–	2690 MHz	FDD
	n41							TDD

6.44.1.2 Channel bandwidths per operating band for CA

Table 6.44.1.2-1: Supported bandwidths per CA band combination of band n1+n41

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n1A-n41A	CA_n1A-n41A	n1	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
		n41	15	Yes	Yes	Yes	Yes			Yes	Yes					
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	

6.44.1.3 Co-existence studies

Table 6.44.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n1-n41.

Table 6.44.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		4th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n1	1920	1980	2110	2170	3840	3960	5760	5940	7680	7920
n41	2496	2690	2496	2690	4992	5380	7488	8070	9984	10760

Based on above table, there is no harmonics issue for the band combination of n1 and n41.

Table 6.44.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic			3rd Harmonic		m th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	
n1	1920	1980	2110	2170	4220	4340	6330	6510			
n41	2496	2690	2496	2690	4992	5380	7488	8070			

Based on above table, there is no harmonics mixing issue for the band combination of n1 and n41.

6.44.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n1-n41, the $\Delta T_{IB,c}$ and ΔR_{IB} can follow the values of DC_1_n41. The values are given in the tables below.

Table 6.44.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n1-n41	n1	0.5
	n41	0.5

Table 6.44.1.4-2: ΔR_{IB}

Inter-band CA Configuration	NR Band	ΔR_{IB} [dB]
CA_n1-n41	n1	0
	n41	0

6.44.1.5 REFSENs requirements

MSD values for cross band isolation are shown below, referring to DC_1_n41 R4-1908940.

Table 6.44.1.5-1: MSD for the CA configuration for asynchronous operation and cross band isolation for CA

NR Band / Channel bandwidth of the affected DL band														
NR CA Configuration	UL band	DL band	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	30 MHz (dB)	40 MHz (dB)	50 MHz (dB)	60 MHz (dB)	80 MHz (dB)	90 MHz (dB)	100 MHz (dB)
CA_n1A-n41A	n41	n1	9.1	9.1	9.1	9.1								
CA_n1A-n41A	n1	n41		6.1	6.1	6.1			6.1	6.1	6.1	6.1	6.1	6.1

NOTE 1: Applicable only when harmonic mixing MSD for this combination is not applied.
 NOTE 2: Void

Table 6.44.1.5-2: Uplink configuration for reference sensitivity exceptions due to cross band isolation for CA

NR Band / SCS / Channel bandwidth of the affected DL band														
UL band	DL band	SCS of UL band (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n41	n1	30	128	128	128	128								
n1	n41	15		100	100	100			100	100	100	100	100	100

NOTE 1: The UL configuration applies regardless of the channel bandwidth of the UL band unless the UL resource blocks exceed that specified in Table 7.3.2-3 for the uplink bandwidth in which case the allocation according to Table 7.3.2-3 applies.
 NOTE 2: Refers to 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 in Table 5.3.2-1.

6.44.2 Specific for 2 bands UL CA

6.44.2.1 UE co-existence studies

Table 6.44.2.1-1 gives IMD interference analysis for CA_n1-n41 with 2 ULs.

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	1920	1980	2496	2690
2 nd harmonics frequency limits (MHz)	2*fx_low	2*fx_high	2* fy_low	2* fy_high
3 rd harmonics frequency limits (MHz)	3*fx_low	3*fx_high	3* fy_low	3* fy_high
4 th harmonics frequency limits (MHz)	4*fx_low	4*fx_high	4* fy_low	4* fy_high
5 th harmonics frequency limits (MHz)	5*fx_low	5*fx_high	5* fy_low	5* fy_high
6 th harmonics frequency limits (MHz)	6*fx_low	6*fx_high	6* fy_low	6* fy_high
7 th harmonics frequency limits (MHz)	7*fx_low	7*fx_high	7* fy_low	7* fy_high
8 th harmonics frequency limits (MHz)	8*fx_low	8*fx_high	8* fy_low	8* fy_high
9 th harmonics frequency limits (MHz)	9*fx_low	9*fx_high	9* fy_low	9* fy_high
10 th harmonics frequency limits (MHz)	10*fx_low	10*fx_high	10* fy_low	10* fy_high

2 nd order IMD products	fy_low – fx_high	fy_high – fx_low	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	516	770	4416	4670
Two-tone 3 rd order IMD products	2*fx_low – fy_high	2*fx_high – fy_low	2*fy_low – fx_high	2*fy_high – fx_low
IMD frequency limits (MHz)	1150	1464	3012	3460
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	6336	6650	6912	7360
Two-tone 4 th order IMD products	3*fx_low – 1*fy_high	3*fx_high – 1*fy_low	3*fy_low – 1*fx_high	3*fy_high – 1*fx_low
IMD frequency limits (MHz)	3070	3444	5508	6150
Two-tone 4 th order IMD products	3*fx_low + 1*fy_low	3*fx_high + 1*fy_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high
IMD frequency limits (MHz)	8256	8630	9408	10050
Two-tone 4 th order IMD products	2*fx_low – 2*fy_high	2*fx_high – 2*fy_low	2*fx_low + 2*fy_low	2*fx_high + 2*fy_high
IMD frequency limits (MHz)	1540	1032	8832	9340
Two-tone 5 th order IMD products	fx_low – 4*fy_high	fx_high – 4*fy_low	fy_low – 4*fx_high	fy_high – 4*fx_low
IMD frequency limits (MHz)	8840	8004	5424	4990
Two-tone 5 th order IMD products	2*fx_low - 3*fy_high	2*fx_high - 3*fy_low	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)	4230	3528	948	380
Two-tone 5 th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
IMD frequency limits (MHz)	11904	12740	10176	10610
Two-tone 5 th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	11328	12030	10752	11320

Based on above table, there is no IMD issue for CA_n1-n41.

Table 6.44.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.44.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA Configuration	Spurious emission				
	Protected Band	Frequency range (Mhz)	Maximum Level (dBm)	MBW (MHz)	NOTE

CA_n1-n41	E-UTRA Band 1, 3, 5, 8, 26, 27, 28, 42, 44, 45, 50, 51, 52, 65, 73, 74 NR Band n78	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA band 34	F_{DL_low}	-	F_{DL_high}	-50	1	4
	NR Band n77, n79	F_{DL_low}	-	F_{DL_high}	-50	1	2
	E-UTRA Band 11, 18, 19, 21	F_{DL_low}	-	F_{DL_high}	-50	1	10
	Frequency range	1884.5	-	1915.7	-41	0.3	3, 10
	Frequency range	1880	-	1895	-40	1	4, 6
	Frequency range	1895	-	1915	-15.5	5	4, 6, 7
	Frequency range	1915	-	1920	+1.6	5	4, 6, 7
<p>NOTE 1: F_{DL_low} and F_{DL_high} refer to each frequency band specified in Table 5.2-1 in TS 38.101-1 or Table 5.5-1 in TS 36.101</p> <p>NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2 \text{ MHz} + N \times L_{CRB} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.</p> <p>NOTE 3: Applicable when co-existence with PHS system operating in 1884.5 -1915.7 MHz</p> <p>NOTE 4: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.</p> <p>NOTE 5: This requirement is applicable only for the following cases: A: for carriers of 5 MHz channel bandwidth when carrier centre frequency (F_c) is within the range $902.5 \text{ MHz} \leq F_c < 907.5 \text{ MHz}$ with an uplink transmission bandwidth less than or equal to 20 RB; B: for carriers of 5 MHz channel bandwidth when carrier centre frequency (F_c) is within the range $907.5 \text{ MHz} \leq F_c \leq 912.5 \text{ MHz}$ without any restriction on uplink transmission bandwidth; D: for carriers of 10 MHz channel bandwidth when carrier centre frequency (F_c) is $F_c = 910 \text{ MHz}$ with an uplink transmission bandwidth less than or equal to 32 RB with $RB_{start} > 3$.</p> <p>NOTE 6: This requirement is applicable for any channel bandwidths within the range 1920 – 1980 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 1927.5 – 1929.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 1930 – 1938 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB.</p> <p>NOTE 7: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.</p> <p>NOTE 8: This requirement is only applicable for carriers with bandwidth confined within 1885-1920 MHz (requirement for carriers with at least 1RB confined within 1880 - 1885 MHz is not specified). This requirement applies for an uplink transmission bandwidth less than or equal to 54 RB for carriers of 15 MHz bandwidth when carrier center frequency is within the range 1892.5 - 1894.5 MHz and for carriers of 20 MHz bandwidth when carrier center frequency is within the range 1895 - 1903 MHz.</p> <p>NOTE 9: This requirement applies for 5, 10, 15 and 20 MHz NR channel bandwidth allocated within 1744.9 MHz and 1784.9 MHz.</p> <p>NOTE 10: This requirement applies when the NR carrier is confined within 2545 - 2575 MHz or 2595 – 2645vMHz and the channel bandwidth is 10 or 20 MHz.</p> <p>NOTE 11: Applicable when the assigned NR carrier is confined within 718 MHz and 748 MHz and when the channel bandwidth used is 5 or 10 MHz.</p> <p>NOTE 12: As exceptions, measurements with a level up to the applicable requirement of -36 dBm/MHz is permitted for each assigned NR carrier used in the measurement due to 3rd harmonic spurious emissions. An exception is allowed if there is at least one individual RB within the transmission bandwidth (see Figure 5.3.1-1) for which the 3rd harmonic totally or partially overlaps the measurement bandwidth (MBW).</p> <p>NOTE 13: This requirement is applicable for 5 and 10 MHz NR channel bandwidth allocated within 718 - 728 MHz. For carriers of 10 MHz bandwidth, this requirement applies for an uplink transmission bandwidth less than or equal to 30 RB with $RB_{start} > 1$ and $Rb_{start} < 48$.</p> <p>NOTE 14: This requirement is applicable in the case of a 10 MHz NR carrier confined within 703 MHz and 733 MHz, otherwise the requirement of -25 dBm with a measurement bandwidth of 8 MHz applies.</p> <p>NOTE 15: As exceptions, measurements with a level up to the applicable requirement of -38 dBm/MHz is permitted for each assigned E-UTRA carrier used in the measurement due to 3rd harmonic spurious emissions. An exception is allowed if there is at least one individual RB within the transmission bandwidth (see Figure 5.6-1) for which the 3rd harmonic totally or partially overlaps the measurement bandwidth (MBW).</p> <p>NOTE 17: Applicable when NS_05 in section 6.6.3.3.1 is signalled by the network.</p> <p>NOTE 18: This requirement is applicable for any channel bandwidths within the range 2500 – 2570 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 2560.5 - 2562.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 2552 – 2560 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB.</p>							

6.44.2.2 REFSENS requirements

There is no MSD issue for two bands UL.

6.45 CA_n28-n41

6.45.1 Common for 1 band UL and 2 bands UL CA

6.45.1.1 Operating bands for CA

Table 6.45.1-1: CA band combination of band n28 + n41

NR CA Band Combination	NR Band	Uplink (UL) band				Downlink (DL) band				Duplex mode				
		BS receive / UE transmit				BS transmit / UE receive								
		$F_{UL_low} - F_{UL_high}$				$F_{DL_low} - F_{DL_high}$								
CA_n28-n41	n28	703 MHz		—		748 MHz		758 MHz		—		803 MHz		FDD
	n41	2496 MHz		—		2690 MHz		2496 MHz		—		2690 MHz		TDD

6.45.1.2 Channel bandwidths per operating band for CA

Table 8.x.2-1: Supported bandwidths per CA band combination of band n7+n78

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n28A-n41A	CA_n28A-n41A	n28	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60													
		n41	15	Yes	Yes	Yes	Yes				Yes	Yes				
			30		Yes	Yes	Yes				Yes	Yes	Yes	Yes	Yes	
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	

6.45.1.3 Co-existence studies

Table 6.45.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n28-n41.

Table 6.45.1.3-1: Impact of UL/DL Harmonic

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2nd Harmonic			3rd Harmonic			4th Harmonic			
					UL Low Band Edge	UL High Band Edge	DL Low Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	
n28	703	748	758	803	1406	1496	2109	2244	2812	2992				
n41	2496	2690	2496	2690	4992	5380	7488	8070	9984	10760				

Based on above table, there is no harmonics issue for the band combination of n28 and n41.

Table 6.45.1.3-2: Impact of UL/DL Harmonic mixing

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2nd Harmonic			3rd Harmonic			m th Harmonic			
					DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	
n28	703	748	758	803	1516	1606	2274	2409						
n41	2496	2690	2496	2690	4992	5380	7488	8070						

Based on above table, there is no harmonics mixing issue for the band combination of n28 and n41.

6.45.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n28-n41, the $\Delta T_{IB,c}$ and ΔR_{IB} can follow the values of DC_28_n41. The values are given in the tables below.

Table 6.45.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n28-n41	n28	0.3
	n41	0.3

Table 6.45.1.4-2: ΔR_{IB}

Inter-band CA Configuration	NR Band	ΔR_{IB} [dB]
CA_n28-n41	n28	0
	n41	0

6.45.1.5 REFSENs requirements

There is no MSD issue for CA_n28-n41 with single UL.

6.45.2 Specific for 2 bands UL CA

6.45.2.1 UE co-existence studies

Table 6.45.2.1-1 gives IMD interference analysis for CA_n28-n41 with 2 ULs.

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	703	748	2496	2690
2 nd harmonics frequency limits (MHz)	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2 nd harmonics frequency limits (MHz)	1406	1496	4992	5380
3 rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3 rd harmonics frequency limits (MHz)	2109	2244	7488	8070
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	2812	2992	9984	10760
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	3515	3740	12480	13450
2 nd order IMD products	fy_low - fx_high	fy_high - fx_low	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	1748	1987	3199	3438

Two-tone 3 rd order IMD products	$ 2*fx_low - fy_high $	$ 2*fx_high - fy_low $	$ 2*fy_low - fx_high $	$ 2*fy_high - fx_low $
IMD frequency limits (MHz)	1284	1000	4244	4677
Two-tone 3 rd order IMD products	$ 2*fx_low + fy_low $	$ 2*fx_high + fy_high $	$ 2*fy_low + fx_low $	$ 2*fy_high + fx_high $
IMD frequency limits (MHz)	3902	4186	5695	6128
Two-tone 4 th order IMD products	$ 3*fx_low - 1*fy_high $	$ 3*fx_high - 1*fy_low $	$ 3*fy_low - 1*fx_high $	$ 3*fy_high - 1*fx_low $
IMD frequency limits (MHz)	581	252	6740	7367
Two-tone 4 th order IMD products	$ 3*fx_low + 1*fy_low $	$ 3*fx_high + 1*fy_high $	$ 3*fy_low + 1*fx_low $	$ 3*fy_high + 1*fx_high $
IMD frequency limits (MHz)	4605	4934	8191	8818
Two-tone 4 th order IMD products	$ 2*fx_low - 2*fy_high $	$ 2*fx_high - 2*fy_low $	$ 2*fx_low + 2*fy_low $	$ 2*fx_high + 2*fy_high $
IMD frequency limits (MHz)	3974	3496	6398	6876
Two-tone 5 th order IMD products	$ fx_low - 4*fy_high $	$ fx_high - 4*fy_low $	$ fy_low - 4*fx_high $	$ fy_high - 4*fx_low $
IMD frequency limits (MHz)	10057	9236	496	122
Two-tone 5 th order IMD products	$ 2*fx_low - 3*fy_high $	$ 2*fx_high - 3*fy_low $	$ 2*fy_low - 3*fx_high $	$ 2*fy_high - 3*fx_low $
IMD frequency limits (MHz)	6664	5992	2748	3271
Two-tone 5 th order IMD products	$ fx_low + 4*fy_low $	$ fx_high + 4*fy_high $	$ fy_low + 4*fx_low $	$ fy_high + 4*fx_high $
IMD frequency limits (MHz)	10687	11508	5308	5682
Two-tone 5 th order IMD products	$ 2*fx_low + 3*fy_low $	$ 2*fx_high + 3*fy_high $	$ 2*fy_low + 3*fx_low $	$ 2*fy_high + 3*fx_high $
IMD frequency limits (MHz)	8894	9566	7101	7624

Based on above table, there is no IMD issue for CA_n28-n41.

Table 6.45.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.45.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA Configuration	Spurious emission						
	Protected Band	Frequency range (Mhz)			Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n28-n41	E-UTRA Band 2, 3, 5, 8, 25, 26, 27, 34	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 4, 10, 42, 50, 51, 52, 65, 66, 73, 74 NR Band n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1	2
	E-UTRA Band 18, 19	F_{DL_low}	-	F_{DL_high}	-50	1	10

	Frequency range	470	-	694	-42	8	4, 14
	Frequency range	470	-	710	-26.2	6	13
	Frequency range	662	-	694	-26.2	6	4
	Frequency range	758	-	773	-32	1	4
	Frequency range	773	-	803	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	3, 10, 11
NOTE 1: F_{DL_low} and F_{DL_high} refer to each frequency band specified in Table 5.2-1 in TS 38.101-1 or Table 5.5-1 in TS 36.101							
NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2 \text{ MHz} + N \times L_{CRB} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.							
NOTE 3: Applicable when co-existence with PHS system operating in 1884.5 -1915.7 MHz							
NOTE 4: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.							
NOTE 5: This requirement is applicable only for the following cases: A: for carriers of 5 MHz channel bandwidth when carrier centre frequency (F_c) is within the range $902.5 \text{ MHz} \leq F_c < 907.5 \text{ MHz}$ with an uplink transmission bandwidth less than or equal to 20 RB; B: for carriers of 5 MHz channel bandwidth when carrier centre frequency (F_c) is within the range $907.5 \text{ MHz} \leq F_c \leq 912.5 \text{ MHz}$ without any restriction on uplink transmission bandwidth; D: for carriers of 10 MHz channel bandwidth when carrier centre frequency (F_c) is $F_c = 910 \text{ MHz}$ with an uplink transmission bandwidth less than or equal to 32 RB with $RB_{start} > 3$.							
NOTE 6: This requirement is applicable for any channel bandwidths within the range 1920 – 1980 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 1927.5 - 1929.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 1930 – 1938 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB.							
NOTE 7: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.							
NOTE 8: This requirement is only applicable for carriers with bandwidth confined within 1885-1920 MHz (requirement for carriers with at least 1RB confined within 1880 - 1885 MHz is not specified). This requirement applies for an uplink transmission bandwidth less than or equal to 54 RB for carriers of 15 MHz bandwidth when carrier center frequency is within the range 1892.5 - 1894.5 MHz and for carriers of 20 MHz bandwidth when carrier center frequency is within the range 1895 - 1903 MHz.							
NOTE 9: This requirement applies for 5, 10, 15 and 20 MHz NR channel bandwidth allocated within 1744.9 MHz and 1784.9 MHz.							
NOTE 10: This requirement applies when the NR carrier is confined within 2545 - 2575 MHz or 2595 – 2645vMHz and the channel bandwidth is 10 or 20 MHz.							
NOTE 11: Applicable when the assigned NR carrier is confined within 718 MHz and 748 MHz and when the channel bandwidth used is 5 or 10 MHz.							
NOTE 12: As exceptions, measurements with a level up to the applicable requirement of -36 dBm/MHz is permitted for each assigned NR carrier used in the measurement due to 3rd harmonic spurious emissions. An exception is allowed if there is at least one individual RB within the transmission bandwidth (see Figure 5.3.1-1) for which the 3rd harmonic totally or partially overlaps the measurement bandwidth (MBW).							
NOTE 13: This requirement is applicable for 5 and 10 MHz NR channel bandwidth allocated within 718 - 728 MHz. For carriers of 10 MHz bandwidth, this requirement applies for an uplink transmission bandwidth less than or equal to 30 RB with $RB_{start} > 1$ and $Rb_{start} < 48$.							
NOTE 14: This requirement is applicable in the case of a 10 MHz NR carrier confined within 703 MHz and 733 MHz, otherwise the requirement of -25 dBm with a measurement bandwidth of 8 MHz applies.							
NOTE 15: As exceptions, measurements with a level up to the applicable requirement of -38 dBm/MHz is permitted for each assigned E-UTRA carrier used in the measurement due to 3rd harmonic spurious emissions. An exception is allowed if there is at least one individual RB within the transmission bandwidth (see Figure 5.6-1) for which the 3rd harmonic totally or partially overlaps the measurement bandwidth (MBW).							
NOTE 17: Applicable when NS_05 in section 6.6.3.3.1 is signalled by the network.							
NOTE 18: This requirement is applicable for any channel bandwidths within the range 2500 – 2570 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 2560.5 - 2562.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 2552 – 2560 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB.							

6.45.2.2 REFSENS requirements

There is no MSD issue for two bands UL.

6.46 CA_n2_n5

6.46.1 Common for 1 band UL and 2 bands UL CA

6.46.1.1 Operating bands for CA

Table 6.46.1.1-1: CA band combination of band n2+n5

NR Band	Uplink (UL) band				Downlink (DL) band				Duplex mode	
	BS receive / UE transmit				BS transmit / UE receive					
	$F_{UL_low} - F_{UL_high}$				$F_{DL_low} - F_{DL_high}$					
n2	1850 MHz – 1910 MHz				1930 MHz – 1990 MHz				FDD	
n5	824 MHz – 849 MHz				869 MHz – 894 MHz				FDD	

6.46.1.2 Channel bandwidths per operating band for CA

Table 6.46.1.2-1: Supported bandwidths per CA band combination of band n2+n5

CA operating / channel bandwidth [MHz]																
NR CA configuration	UL configuration	NR Band	SCS (kHz)	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n2A-n5A	CA_n2A-n5A	n2	15	Yes	Yes	Yes	Yes									0
			30	Yes		Yes	Yes									
			60	Yes		Yes	Yes									
		n5	15	Yes	Yes	Yes	Yes									
			30		Yes	Yes	Yes									
			60													

6.46.1.3 Co-existence studies

Table 6.36.1.3-1 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n2-n5.

Table 6.46.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		4th Harmonic		5th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n2	1850	1910	1930	1990	3700	3820	5550	5730	7400	7640	9250	9550
n5	824	849	869	894	1648	1698	2472	2547	3296	3396	4120	4245

Based on Table 6.x.1.3-1, it can be seen that there is no harmonic skirt interference from band n5 to impact the receive frequency of band n2.

6.46.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n2-n5, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values for UEs are given in the tables below.

Table 6.46.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n2-n5	n2	0.3
	n5	0.3

Table 6.46.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n2-n5	n2	0
	n5	0

6.46.1.5 REFSEN requirements

Same REFSENS requirements will be applied from 38.101-1. There is no need for additional REFSENS requirements.

6.46.2 Specific for 2 bands UL CA

6.46.2.1 UE co-existence studies

Table 6.46.2.1-1 lists Band n2 + Band n5 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.46.2.1-1: Band n2 and Band n5 UL IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	1850	1910	824	849
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3700	3820	1648	1698
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5550	5730	2472	2547
4th harmonics frequency limits	4*fx_low	4*fx_high	4*fy_low	4*fy_high
4th harmonics frequency limits (MHz)	7400	7640	3296	3396
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	9250	9550	4120	4245
Two tone 2nd order IMD products	fy_low – fx_high	fy_high – fx_low	fx_low + fy_low	fx_high + fy_high

IMD frequency limits (MHz)	1086	1001	2674	2759
Two-tone 3 rd order IMD products	$ 2*fx_low - fy_high $	$ 2*fx_high - fy_low $	$ 2*fy_low - fx_high $	$ 2*fy_high - fx_low $
IMD frequency limits (MHz)	2851	2996	262	152
Two-tone 3 rd order IMD products	$2*fx_low + fy_low$	$2*fx_high + fy_high$	$2*fy_low + fx_low$	$2*fy_high + fx_high$
IMD frequency limits (MHz)	4524	4669	3498	3608
Two-tone 3 rd order IMD products	$2*fx_low + fy_low$	$2*fx_high + fy_high$	$2*fy_low + fx_low$	$2*fy_high + fx_high$
IMD frequency limits (MHz)	4524	4669	3498	3608
Two-tone 4th order IMD products	$ 3*fx_low - fy_high $	$ 3*fx_high - fy_low $	$3*fy_low - fx_high$	$3*fy_high - fx_low$
IMD frequency limits (MHz)	4701	4906	562	697
Two-tone 4th order IMD products	$3*fx_low + fy_low$	$3*fx_high + fy_high$	$3*fy_low + fx_low$	$3*fy_high + fx_high$
IMD frequency limits (MHz)	6374	6579	4322	4457
Two-tone 4th order IMD products	$ 2*fx_low - 2*fy_high $	$ 2*fx_high - 2*fy_low $	$2*fx_low + 2*fy_low$	$2*fx_high + 2*fy_high$
IMD frequency limits (MHz)	2002	2172	5348	5518
Two-tone 5th order IMD products	$ fx_low - 4*fy_high $	$ fx_high - 4*fy_low $	$ fy_low - 4*fx_high $	$ fy_high - 4*fx_low $
IMD frequency limits (MHz)	1546	1386	6816	6551
Two-tone 5th order IMD products	$ fx_low + 4*fy_low $	$ fx_high + 4*fy_high $	$ fy_low + 4*fx_low $	$ fy_high + 4*fx_high $
IMD frequency limits (MHz)	5146	5306	8224	8489
Two-tone 5th order IMD products	$ 2*fx_low - 3*fy_high $	$ 2*fx_high - 3*fy_low $	$ 2*fy_low - 3*fx_high $	$ 2*fy_high - 3*fx_low $
IMD frequency limits (MHz)	1153	1348	4082	3852
Two-tone 5th order IMD products	$ 2*fx_low + 3*fy_low $	$ 2*fx_high + 3*fy_high $	$ 2*fy_low + 3*fx_low $	$ 2*fy_high + 3*fx_high $
IMD frequency limits (MHz)	6172	6367	7198	7428

Based on Table 6.46.2.1-1, there is no harmonics product found to fall into Rx frequencies of band n2 and no IMD falls into its band n2 Rx frequencies.

Based on the Table 6.46.2.1-1;

- the 2nd harmonics may fall into n43, n77 and n78 Rx frequency
- the 3rd harmonics may fall into B46, n41 and n90 Rx frequency
- the 4th harmonics may fall into B53 and n77 and n78 Rx frequency
- the 5th harmonics may fall into n77 Rx frequency
- the 2nd IMD may fall into n7, n41 and n90 Rx frequency
- the 3rd IMD may fall into B22, B47, n49, B41, n77, n78, n79 Rx frequency
- the 4th IMD may fall into n1, B4, B10, n34, B46, n65, n66, n70, n79 Rx frequency
- the 5th IMD may fall into B46, n77 Rx frequency

Table 6.46.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.46.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configura- tion	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n2-n5	E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 25, 26, 28, 29, 30, 42, 48,	F_{DL_low}	-	F_{DL_high}	-50	1

6.48 CA_n3-n77

6.48.1 Common for 1 band UL and 2 bands UL CA

6.48.1.1 Operating bands for CA

Table 6.48.1.1-1: CA band combination of band n3+n77

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
	BS receive / UE transmit		BS transmit / UE receive			
	$F_{UL_low} - F_{UL_high}$		$F_{DL_low} - F_{DL_high}$			
n3	1710 MHz – 1785 MHz		1805 MHz – 1880 MHz		FDD	
n77	3300 MHz – 4200 MHz		3300 MHz – 4200 MHz		TDD	

6.48.1.2 Channel bandwidths per operating band for CA

Table 6.48.1.2-1: Supported bandwidths per CA band combination of band n3+n77

6.48.1.3 Co-existence studies

The studies for 1 band UL for the CA band combination of band n3 + n77 have been already completed and captured into TR 37.865-01-01.

6.48.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n3-n77, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are already specified in TR37.865-01-01.

6.48.1.5 REFSENS requirements

The studies for 1 band UL for the CA band combination of band n3 + n77 have been already completed and captured into TR 37.865-01-01.

6.48.2 Specific for 2 bands UL CA

6.48.2.1 UE co-existence studies

Table 6.48.2.1-1 lists Band n3 +Band n77 2UL CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.48.2.1-1: Band n3 and Band n77 UL IMD products

BS DL carriers	f1_low	f1_high	f2_low	f2_high
DL frequency (MHz)	1710	1785	3300	4200
2nd order IMD products	$ f_2_{low} - f_1_{high} $	$ f_2_{high} - f_1_{low} $	$ f_2_{low} + f_1_{low} $	$ f_2_{high} + f_1_{high} $
IMD frequency limits (MHz)	1515	2490	5010	5985
Two-tone 3rd order IMD products	$ 2*f_1_{low} - f_2_{high} $	$ 2*f_1_{high} - f_2_{low} $	$ 2*f_2_{low} - f_1_{high} $	$ 2*f_2_{high} - f_1_{low} $
IMD frequency limits (MHz)	780	270	4815	6690
Two-tone 3rd order IMD products	$ 2*f_1_{low} + f_2_{low} $	$ 2*f_1_{high} + f_2_{high} $	$ 2*f_2_{low} + f_1_{low} $	$ 2*f_2_{high} + f_1_{high} $
IMD frequency limits (MHz)	6720	7770	8310	10185
Two-tone 4th order IMD products	$ 3*f_1_{low} - 1*f_2_{high} $	$ 3*f_1_{high} - 1*f_2_{low} $	$ 3*f_2_{low} - 1*f_1_{high} $	$ 3*f_2_{high} - 1*f_1_{low} $
IMD frequency limits (MHz)	930	2055	8115	10890
Two-tone 4th order IMD products	$ 2*f_1_{low} - 2*f_2_{high} $	$ 2*f_1_{high} - 2*f_2_{low} $		
IMD frequency limits (MHz)	3030	4980		
Two-tone 4th order IMD products	$ 3*f_1_{low} + 1*f_2_{low} $	$ 3*f_1_{high} + 1*f_2_{high} $	$ 3*f_2_{low} + 1*f_1_{low} $	$ 3*f_2_{high} + 1*f_1_{high} $
IMD frequency limits (MHz)	8430	9555	11610	14385
Two-tone 4th order IMD products	$ 2*f_1_{low} + 2*f_2_{low} $	$ 2*f_1_{high} + 2*f_2_{high} $		
IMD frequency limits (MHz)	10020	11970		
Two-tone 5th order IMD products	$ f_1_{low} - 4*f_2_{high} $	$ f_1_{high} - 4*f_2_{low} $	$ f_2_{low} - 4*f_1_{high} $	$ f_2_{high} - 4*f_1_{low} $
IMD frequency limits (MHz)	15090	11415	3840	2640
Two-tone 5th order IMD products	$ 2*f_1_{low} - 3*f_2_{high} $	$ 2*f_1_{high} - 3*f_2_{low} $	$ 2*f_2_{low} - 3*f_1_{high} $	$ 2*f_2_{high} - 3*f_1_{low} $
IMD frequency limits (MHz)	9180	6330	1245	3270
Two-tone 5th order IMD products	$ f_1_{low} + 4*f_2_{low} $	$ f_1_{high} + 4*f_2_{high} $	$ f_2_{low} + 4*f_1_{low} $	$ f_2_{high} + 4*f_1_{high} $
IMD frequency limits (MHz)	14910	18585	10140	11340
Two-tone 5th order IMD products	$ 2*f_1_{low} + 3*f_2_{low} $	$ 2*f_1_{high} + 3*f_2_{high} $	$ 2*f_2_{low} + 3*f_1_{low} $	$ 2*f_2_{high} + 3*f_1_{high} $
IMD frequency limits (MHz)	13320	16170	11730	13755

Based on Table 6.48.2.1-1, 2nd, 3rd and 5th order IMD may also fall into own Rx of band n3.

Table 6.48.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.2.2.1-2: Protected bands for the 2UL bands CA configuration

6.48.2.2 REFSENS requirements

The same MSD requirements of DC_3_n77 can be applied to this combination. Table 6.48.2.2-1 lists the MSD requirements for the dual uplink configuration.

Table 6.48.2.2-1: MSD due to IMD issue

Operating band / Channel bandwidth / N _{RB} / Duplex mode								Source of IMD
CA Configuration	Operating band	UL F _c (MHz)	UL/DL BW (MHz)	UL C _{L,RB}	DL F _c (MHz)	MSD (dB)	Duplex mode	
CA_n3-n77	n3	1740	5	25	1835	26	FDD	IMD2 ³
	n77	3575	10	50	3575	N/A	TDD	N/A
CA_n3-n77	n3	1765	5	25	1860	8.0	FDD	IMD4 ³
	n77	3435	10	50	3435	10.7 ⁴	TDD	N/A

6.49 CA_n20-n78

6.49.1 Common for 1 band UL and 2 bands UL CA

6.49.1.1 Operating bands for CA

Table 6.49.1.1-1: CA band combination CA_n20A-n78A

NR CA Band Combination	NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
		BS receive / UE transmit			BS transmit / UE receive				
		$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$				
CA_n20-n78	n20	832 MHz – 862 MHz		791 MHz – 821 MHz		FDD		TDD	
	n78	3300 MHz – 3800 MHz		3300 MHz – 3800 MHz					

6.49.1.2 Channel bandwidths per operating band for CA

Table 6.49.1.2-1: Supported bandwidths per CA band combination CA_n20A-n78A

CA operating / channel bandwidth [MHz]																0
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	
CA_n20A-n78A	CA_n20A-n78A	n20	15	Yes	Yes	Yes	Yes									
			30		Yes	Yes	Yes									
		n78	15		Yes	Yes	Yes			Yes	Yes					
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	

6.49.1.3 Co-existence studies

Table 6.49.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n20-n78.

Table 6.49.1.3-1: Impact of UL/DL Harmonic

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	2nd Harmonic			3rd Harmonic		4th Harmonic	
				DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n20	832	862	791	821	1664	1724	2496	2586	3328	3448
n78	3300	3800	3300	3800	6600	7600	9900	11400	13200	15200

Based on above table, the 4th harmonics of band n20 UL will fall into the band n78 Rx.

Table 6.49.1.3-2: Impact of UL/DL Harmonic mixing

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	2nd Harmonic			3rd Harmonic		m th Harmonic	
				DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n7	832	862	791	821	1582	1642	2373	2463		
n78	3300	3800	3300	3800	6600	7600	9900	11400		

Based on above table, there is no harmonics mixing issue for the band combination of n20 and n78.

6.49.1.4 $\Delta T_{IB,c}$ and ΔR_{IB} values

For CA_n20A-n78A, the $\Delta T_{IB,c}$ and ΔR_{IB} can follow the values of DC_20_n78. The values are given in the tables below.

Table 6.49.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n20-n78	n20	0.6
	n78	0.8

Table 6.49.1.4-2: ΔR_{IB}

Inter-band CA Configuration	NR Band	ΔR_{IB} [dB]
CA_n20-n78	n20	0
	n78	0.5

6.49.1.5 REFSENs requirements

The specific MSD requirement can follow the requirements of DC_20_n78 as below.

Table 6.49.1.5-1: Reference sensitivity exceptions due to UL harmonic for NR CA FR1

MSD due to harmonic exception for the DL band													
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
		dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
n20	n78 ^{2,4}		10.8	9.1	8			6	4.0	3.2	2.0	1.5	1.0

NOTE 2: The requirements should be verified for UL EARFCN of the aggressor (lower) band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.5 \rfloor + 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with carrier frequency in the victim (higher) band in MHz and the channel bandwidth configured in the lower band.

NOTE 4: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (lower) band for which the 4th transmitter harmonic is within the downlink transmission bandwidth of a victim (higher) band.

Table 6.49.1.5-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for NR CA, FR1

NR Band / Channel bandwidth of the high band													
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n20	n78		16	25	25			25	25	25	25	25	25

6.49.2 Specific for 2 bands UL CA

6.49.2.1 UE co-existence studies

Table 6.49.2.1-1 gives IMD interference analysis for CA_n20-n78 with 2 ULs.

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	832	862	3300	3800

2^{nd} harmonics frequency limits	2^*fx_{low}	2^*fx_{high}	2^*fy_{low}	2^*fy_{high}
2 nd harmonics frequency limits (MHz)	1664	1724	6600	7600
3 rd harmonics frequency limits	3^*fx_{low}	3^*fx_{high}	3^*fy_{low}	3^*fy_{high}
3 rd harmonics frequency limits (MHz)	2496	2586	9900	11400
4th harmonics frequency limits	4^*fx_{low}	4^*fx_{high}	4^*fy_{low}	4^*fy_{high}
4th harmonics frequency limits (MHz)	3328	3448	13200	15200
5th harmonics frequency limits	5^*fx_{low}	5^*fx_{high}	5^*fy_{low}	5^*fy_{high}
5th harmonics frequency limits (MHz)	4160	4310	16500	19000
2 nd order IMD products	$ fy_{\text{low}} - fx_{\text{high}} $	$ fy_{\text{high}} - fx_{\text{low}} $	$ fy_{\text{low}} + fx_{\text{low}} $	$ fy_{\text{high}} + fx_{\text{high}} $
IMD frequency limits (MHz)	2438	2968	4132	4662
Two-tone 3 rd order IMD products	$ 2^*fx_{\text{low}} - fy_{\text{high}} $	$ 2^*fx_{\text{high}} - fy_{\text{low}} $	$ 2^*fy_{\text{low}} - fx_{\text{high}} $	$ 2^*fy_{\text{high}} - fx_{\text{low}} $
IMD frequency limits (MHz)	2136	1576	5738	6768
Two-tone 3 rd order IMD products	$ 2^*fx_{\text{low}} + fy_{\text{low}} $	$ 2^*fx_{\text{high}} + fy_{\text{high}} $	$ 2^*fy_{\text{low}} + fx_{\text{low}} $	$ 2^*fy_{\text{high}} + fx_{\text{high}} $
IMD frequency limits (MHz)	4964	5524	7432	8462
Two-tone 4 th order IMD products	$ 3^*fx_{\text{low}} - 1^*fy_{\text{high}} $	$ 3^*fx_{\text{high}} - 1^*fy_{\text{low}} $	$ 3^*fy_{\text{low}} - 1^*fx_{\text{high}} $	$ 3^*fy_{\text{high}} - 1^*fx_{\text{low}} $
IMD frequency limits (MHz)	1304	714	9038	10568
Two-tone 4 th order IMD products	$ 3^*fx_{\text{low}} + 1^*fy_{\text{low}} $	$ 3^*fx_{\text{high}} + 1^*fy_{\text{high}} $	$ 3^*fy_{\text{low}} + 1^*fx_{\text{low}} $	$ 3^*fy_{\text{high}} + 1^*fx_{\text{high}} $
IMD frequency limits (MHz)	5796	6386	10732	12262
Two-tone 4 th order IMD products	$ 2^*fx_{\text{low}} - 2^*fy_{\text{high}} $	$ 2^*fx_{\text{high}} - 2^*fy_{\text{low}} $	$ 2^*fx_{\text{low}} + 2^*fy_{\text{low}} $	$ 2^*fx_{\text{high}} + 2^*fy_{\text{high}} $
IMD frequency limits (MHz)	5936	4876	8264	9324
Two-tone 5 th order IMD products	$ fx_{\text{low}} - 4^*fy_{\text{high}} $	$ fx_{\text{high}} - 4^*fy_{\text{low}} $	$ fy_{\text{low}} - 4^*fx_{\text{high}} $	$ fy_{\text{high}} - 4^*fx_{\text{low}} $
IMD frequency limits (MHz)	14368	12338	148	472
Two-tone 5 th order IMD products	$ 2^*fx_{\text{low}} - 3^*fy_{\text{high}} $	$ 2^*fx_{\text{high}} - 3^*fy_{\text{low}} $	$ 2^*fy_{\text{low}} - 3^*fx_{\text{high}} $	$ 2^*fy_{\text{high}} - 3^*fx_{\text{low}} $
IMD frequency limits (MHz)	9736	8176	4014	5104
Two-tone 5 th order IMD products	$ fx_{\text{low}} + 4^*fy_{\text{low}} $	$ fx_{\text{high}} + 4^*fy_{\text{high}} $	$ fy_{\text{low}} + 4^*fx_{\text{low}} $	$ fy_{\text{high}} + 4^*fx_{\text{high}} $
IMD frequency limits (MHz)	14032	16062	6628	7248

Two-tone 5 th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	11564	13124	9096	10186

Based on above table, the 4rd order IMD may fall into Rx frequencies of Band n20. The IMD4 issue should be considered for CA_n20-n78.

Table 6.49.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.49.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA Configuration	Spurious emission						NOTE
	Protected Band	Frequency range (Mhz)			Maximum Level (dBm)	MBW (MHz)	
CA_n20-n78	E-UTRA Band 1, 3, 7, 8, 34, 40, 65	F _{DL_low}	-	F _{DL_high}	-50	1	
	E-UTRA Band 20	F _{DL_low}	-	F _{DL_high}	-50	1	4
	E-UTRA Band 38, 69	F _{DL_low}	-	F _{DL_high}	-50	1	2

NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of (2 MHz + N x L_{CRB} x 180kHz), where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.

NOTE 4: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

6.49.2.2 REFSENS requirements

The specific MSD requirement of IMD4 can follow the requirements of DC_20_n78 as below.

Table 6.49.2.2-1: 2DL/2UL interband Reference sensitivity QPSK P_{REFSENS} and uplink/downlink configurations

Band / Channel bandwidth / N _{RB} / Duplex mode								Source of IMD
NR CA Configuration	NR band	UL F _c (MHz)	UL/DL BW (MHz)	UL C _{LRB}	DL F _c (MHz)	MSD (dB)	Duplex mode	
CA_n20A-n78A	n20	850	5	25	809	11	FDD	IMD4
	n78	3359	10	50	3359	N/A	TDD	N/A

6.50 CA_n1-n7

6.50.1 Common for 1 band UL and 2 bands UL CA

6.50.1.1 Operating bands for CA

Table 6.50.1.1-1: CA band combination of band n1 and n7

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
	BS receive / UE transmit		BS transmit / UE receive			
	F _{UL_low} – F _{UL_high}		F _{DL_low} – F _{DL_high}			
n1	1920 MHz	–	1980 MHz	2110 MHz	FDD	
n7	2500 MHz	–	2570 MHz	2620 MHz		
				2690 MHz		

6.50.1.2 Channel bandwidths per operating band for CA

Table 6.50.1.2-1: Supported bandwidths per CA band combination of band n1 and n7

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Bandwidth combination set
CA_n1A-n7A	CA_n1A-n7A	n1	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
		n7	15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes					
		n7	30		Yes											
			60		Yes											

6.50.1.3 UE co-existence studies

Table 6.50.1.3-1 lists up to 7th harmonics for n1A-n7A.

Table 6.50.1.3-1: Impact of UL/DL Harmonic

		2 nd Harmonic	3 rd Harmonic	4 th Harmonic	5 th Harmonic	6 th Harmonic	7 th Harmonic							
Band	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n1	1920	1980	3840	3960	5760	5940	7680	7920	9600	9900	11520	11880	13440	13860
n7	2500	2570	5000	5140	7500	7710	10000	10280	12500	12850	15000	15420	17500	17990

6.50.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n1-n7, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are derived from LTE combination CA_1-3 and are given in the tables below.

Table 6.50.1.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
CA_n1-n7	n1	0.5
	n7	0.6

Table 6.50.1.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
CA_n1-n7	n1	0
	n7	0

6.50.1.5 REFSENS requirements

As can be seen in the co-existence studies in 6.50.1.3 there are no harmonics issues.

6.50.2 Specific for 2 bands UL CA

6.50.2.1 UE co-existence studies

Table 6.50.2.1-1 lists Band n1 + Band n7 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.50.2.1-1: Band n1 and Band n7 UL IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	1920	1980	2500	2570
2nd harmonics frequency limits	$2^* fy_low$	$2^* fy_high$	$2^* fx_low$	$2^* fx_high$
2nd harmonics frequency limits (MHz)	3840	3960	5000	5140
3rd harmonics frequency limits	$3^* fy_low$	$3^* fy_high$	$3^* fx_low$	$3^* fx_high$
3rd harmonics frequency limits (MHz)	5760	5940	7500	7710
4th harmonics frequency limits	$4^* fy_low$	$4^* fy_high$	$4^* fx_low$	$4^* fx_high$
4th harmonics frequency limits (MHz)	7680	7920	10000	10280
5th harmonics frequency limits	$5^* fy_low$	$5^* fy_high$	$5^* fx_low$	$5^* fx_high$
5th harmonics frequency limits (MHz)	9600	9900	12500	12850
6th harmonics frequency limits	$6^* fy_low$	$6^* fy_high$	$6^* fx_low$	$6^* fx_high$
6th harmonics frequency limits (MHz)	11520	11880	15000	15420
7th harmonics frequency limits	$7^* fy_low$	$7^* fy_high$	$7^* fx_low$	$7^* fx_high$
7th harmonics frequency limits (MHz)	13440	13860	17500	17990
2nd order IMD products	$ fy_high - fx_low $	$ fy_low - fx_high $	$ fy_low + fx_low $	$ fy_high + fx_high $
IMD frequency limits (MHz)	650	520	4420	4550
3rd order IMD products	$ fy_high - 2^* fx_low $	$ fy_low - 2^* fx_high $	$ 2^* fy_low - fx_high $	$ 2^* fy_high - fx_low $
IMD frequency limits (MHz)	1270	1460	3020	3220
3rd order IMD products	$ 2^* fx_low + fy_low $	$ 2^* fx_high + fy_high $	$ 2^* fy_low + fx_low $	$ 2^* fy_high + fx_high $
IMD frequency limits (MHz)	6340	6530	6920	7120
Two-tone 4th order IMD products	$ 2^* fx_low - 2^* fy_high $	$ 2^* fx_high - 2^* fy_low $	$ 2^* fx_low + 2^* fy_low $	$ 2^* fx_high + 2^* fy_high $
IMD frequency limits (MHz)	1300	1040	8840	9100
Two-tone 4th order IMD products	$ 3^* fx_low - 1^* fy_high $	$ 3^* fx_high - 1^* fy_low $	$ 3^* fy_low - 1^* fx_high $	$ 3^* fy_high - 1^* fx_low $
IMD frequency limits (MHz)	3190	3440	5520	5790
Two-tone 4th order IMD products	$ 3^* fx_low + 1^* fy_low $	$ 3^* fx_high + 1^* fy_high $	$ 3^* fy_low + 1^* fx_low $	$ 3^* fy_high + 1^* fx_high $
IMD frequency limits (MHz)	8260	8510	9420	9690
Two-tone 5th order IMD products	$ fx_low - 4^* fy_high $	$ fx_high - 4^* fy_low $	$ fy_low - 4^* fx_high $	$ fy_high - 4^* fx_low $
IMD frequency limits (MHz)	8360	8020	5420	5110
Two-tone 5th order IMD products	$ fx_low + 4^* fy_low $	$ fx_high + 4^* fy_high $	$ fy_low + 4^* fx_low $	$ fy_high + 4^* fx_high $
IMD frequency limits (MHz)	11920	12260	10180	10490
Two-tone 5th order IMD products	$ 2^* fx_low - 3^* fy_high $	$ 2^* fx_high - 3^* fy_low $	$ 2^* fy_low - 3^* fx_high $	$ 2^* fy_high - 3^* fx_low $
IMD frequency limits (MHz)	3870	3540	940	620
Two-tone 5th order IMD products	$ 2^* fx_low + 3^* fy_low $	$ 2^* fx_high + 3^* fy_high $	$ 2^* fy_low + 3^* fx_low $	$ 2^* fy_high + 3^* fx_high $
IMD frequency limits (MHz)	11340	11670	10760	11080

Based on Table 6.50.2.1-1 there are no IMD issues affecting own Rx frequencies of either band n1 or band n7.

Table 6.50.2.1-2 lists the protected bands required for the 2UL bands CA configuration as to be used in Table 6.5A.3.2.3-1 of TS 38.101-1

Table 6.50.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n1-n7	E-UTRA Band 1, 5, 7, 8, 20, 22, 26, 27, 28, 31, 32, 40, 42, 43, 50, 51, 52, 65, 67, 68, 72, 74, 75, 76 NR Band n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1
	band n77	F_{DL_low}	-	F_{DL_high}	-50	1
	band 3, 34	F_{DL_low}	-	F_{DL_high}	-50	1
	Frequency range	1880		1895	-40	1
	Frequency range	1895		1915	-15.5	5
	Frequency range	1915		1920	+1.6	5
	Frequency range	2570	-	2575	+1.6	5
	Frequency range	2575	-	2595	-15.5	5
	Frequency range	2595	-	2620	-40	1
<p>NOTE 1: F_{DL_low} and F_{DL_high} refer to each frequency band specified in Table 5.2-1 in TS 38.101-1 or Table 5.5-1 in TS 36.101</p> <p>NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2 \text{ MHz} + N \times L_{CRB} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.</p> <p>NOTE 4: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.</p> <p>NOTE 6: This requirement is applicable for any channel bandwidths within the range 1920 – 1980 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 1927.5 - 1929.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 1930 – 1938 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB.</p> <p>NOTE 7: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.</p> <p>NOTE 18: This requirement is applicable for any channel bandwidths within the range 2500 – 2570 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 2560.5 - 2562.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 2552 – 2560 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB.</p>						

6.50.2.2 REFSENS requirements

Based on the co-existence studies in 6.50.1.3, there are no need to define MSD for CA_n1-n7.

6.51 CA_n29-n70

6.51.1 Common for 1 band UL and 2 bands UL CA

6.51.1.1 Operating bands for CA

Table 6.51.1.1-1: CA band combination of band n29+n70

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
	BS receive / UE transmit			BS transmit / UE receive				
	$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$				
n29	N/A			717 – 728			SDL	
n70	1695 – 1710			1995 – 2020			FDD	

6.51.1.2 Channel bandwidths per operating band for CA

Table 6.51.1.2-1: Supported bandwidths per CA band combination of band n29+n70

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n29A-n70A	n29	n29	15	Yes	Yes											0
			30		Yes											
			60													
		n70	15	Yes	Yes	Yes	Yes ¹	Yes ¹								
			30		Yes	Yes	Yes ¹	Yes ¹								
			60		Yes	Yes	Yes ¹	Yes ¹								

NOTE 1: This UE channel bandwidth is applicable only to downlink

6.51.1.3 UE co-existence studies

Table 6.51.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n29-n70.

Table 6.51.1.3-1: Impact of UL/DL Harmonic

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2nd Harmonic		3rd Harmonic		nth Harmonic	
					UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n29	N/A	N/A	717	728	N/A	N/A	N/A	N/A	N/A	N/A
n70	1695	1710	1995	2020	3390	3420	5085	5130		

Based on the table above, there is no harmonic relation.

Table 6.51.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic		3rd Harmonic		mth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n29	N/A	N/A	717	728	1434	1456	2151	2184	N/A	N/A
n70	1695	1710	1995	2020	3990	4040	5985	6060		

Based on the table above, there is no harmonic mixing relation.

6.51.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n29-n70, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are given in the tables below.

Table 6.51.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n29-n70	n70	0.3

Table 6.51.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n29-n70	n70	0

6.51.1.5 REFSENS requirements

REFSENS is defined in TS38.101-1 Table 7.3A.2.4-1, because n29A is an SDL band.

Table 6.51.1.5-1: Reference sensitivity for SDL bands

NR Band/Channel bandwidth														
NR CA Configuration	NR band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	
			dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	
CA_n29A-n70A	n29	15	-97.0	-93.8										
		30		-94.1										
		60												
	n70	15	-100	-96.8	-95.0	-93.8	-92.7							
		30		-97.1	-95.1	-94.0	-92.8							
		60		-97.5	-95.4	-94.2	-93.0							

NOTE 1: The transmitter shall be set to P_{UMAX} , as defined in subclause 6.2.4.

6.52 CA_n29-n66

6.52.1 Common for 1 band UL and 2 bands UL CA

6.52.1.1 Operating bands for CA

Table 6.52.1.1-1: CA band combination of band n29+n66

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode
	BS receive / UE transmit		BS transmit / UE receive				
	$F_{UL_low} - F_{UL_high}$	$F_{DL_low} - F_{DL_high}$					
n29	N/A			717 – 728			SDL
n66	1710 – 1780			2110 – 2200			FDD

6.52.1.2 Channel bandwidths per operating band for CA

Table 6.52.1.2-1: Supported bandwidths per CA band combination of band n29+n66

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n29A-n66B	-	n29	15	Yes	Yes											0
			30		Yes											
			60													
		n66	See CA_n66B Bandwidth Combination Set 0 in Table 5.5A.1-1 in TS38.101-1													
CA_n29A-n66(2A)	-	n29	15	Yes	Yes											0
			30		Yes											
			60													
		n66	See CA_n66(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1 in TS38.101-1													

6.52.1.3 UE co-existence studies

Table 6.52.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n29-n66.

Table 6.52.1.3-1: Impact of UL/DL Harmonic

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2nd Harmonic		3rd Harmonic		nth Harmonic	
					UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n29	N/A	N/A	717	728	N/A	N/A	N/A	N/A	N/A	N/A
n66	1710	1780	2110	2200	3420	3560	5130	5340		

Based on the table above, there is no harmonic relation.

Table 6.52.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic		3rd Harmonic		mth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n29	N/A	N/A	717	728	1434	1456	2151	2184	N/A	N/A
n66	1710	1780	2110	2200	4220	4400	6330	6600		

Based on the table above, there is no harmonic mixing relation.

6.52.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n29-n66, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are already defined in CA_n29A-n66A

6.52.1.5 REFSENS requirements

REFSENS is defined in TS38.101-1 Table 7.3A.2.4-1, because n29A is an SDL band.

Table 6.52.1.5-1: Reference sensitivity for SDL bands

NR Band/Channel bandwidth														
NR CA Configuration	NR band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	
			dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	
CA_n29A-n66B	n29	15	-97.0	-93.8										
		30		-94.1										
		60												
	n66	15	-99.5	-96.3	-94.5	-93.3			-90.1					
		30		-96.6	-94.6	-93.5			-90.2					
		60		-97.0	-94.9	-93.7			-90.4					
CA_n29A-n66(2A)	n29	15	-97.0	-93.8										
		30		-94.1										
		60												
	n66	15	-99.5	-96.3	-94.5	-93.3			-90.1					
		30		-96.6	-94.6	-93.5			-90.2					
		60		-97.0	-94.9	-93.7			-90.4					

NOTE 1: The transmitter shall be set to P_{UMAX} , as defined in subclause 6.2.4.

6.53 CA_n3-n38

6.53.1 Common for 1 band UL and 2 bands UL CA

6.53.1.1 Operating bands for CA

Table 6.53.1.1-1: CA band combination of band n3+n38

NR CA Band	NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
		BS receive / UE transmit		BS transmit / UE receive			
		$F_{UL_low} - F_{UL_high}$		$F_{DL_low} - F_{DL_high}$			

CA_n3-n38	n3	1710 MHz – 1785 MHz	1805 MHz – 1880 MHz	FDD
	n38	2570 MHz – 2620 MHz	2570 MHz – 2620 MHz	TDD

6.53.1.2 Channel bandwidths per operating band for CA

Table 6.53.2-1: Supported bandwidths per CA band combination of band n3+n38

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n3A-n38A	CA_n3A-n38A	n3	15	Ye s	Ye s	Ye s	Ye s	Ye s	Ye s							0
			30		Ye s	Ye s	Ye s	Ye s	Ye s							
			60		Ye s	Ye s	Ye s	Ye s	Ye s							
		n38	15	Ye s	Ye s	Ye s	Ye s			Ye s						
			30		Ye s	Ye s	Ye s			Ye s						
			60		Ye s	Ye s	Ye s			Ye s						

6.53.1.3 Co-existence studies

Table 6.53.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n3-n38.

Table 6.53.1.3-1: Impact of UL/DL Harmonic

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2nd Harmonic		3rd Harmonic		nth Harmonic	
					UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n3	1710	1785	1805	1880	3420	3570	5130	5355		
n38	2570	2620	2570	2620	5140	5240	7710	7860		

Based on above table, there is no harmonic issue for the band combination of n3 and n38.

Table 6.53.1.3-2: Impact of UL/DL Harmonic mixing

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2nd Harmonic		3rd Harmonic		nth Harmonic	
					DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n3	1710	1785	1805	1880	3610	3760	5415	5640		
n38	2570	2620	2570	2620	5140	5240	7710	7860		

Based on above table, there is no harmonic mixing issue for the band combination of n3 and n38.

6.53.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n3-n38, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.53.1.4-1: $\Delta T_{IB,c}$

NR CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n3-n38	n3	0.5
	n38	0.5

Table 6.53.1.4-2: $\Delta R_{IB,c}$

NR CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n3-n38	n3	0
	n38	0

6.53.1.5 REFSEN requirements

According to the analysis in subclause 6.53.1.3, there are no harmonic issues for this combination. Hence it is no need to define the MSD values caused by harmonic issues for NR CA n3+n38 band combination.

6.53.2 Specific for 2 bands UL CA

6.53.2.1 UE co-existence studies

Table 6.53.2.1-1 lists Band n3 +Band n38 2UL CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.53.2.1-1: Band n3 and Band n38 UL IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1710	1785	2570	2620
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3420	3570	5140	5240
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5130	5355	7710	7860
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	6840	7140	10280	10480
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	8550	8925	12850	13100
2nd order IMD products	fy_low - fx_high	fy_high - fx_low	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	785	910	4280	4405
Two-tone 3rd order IMD products	2*fx_low - fy_high	2*fx_high - fy_low	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	800	1000	3355	3530
Two-tone 3rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	5990	6190	6850	7025

Two-tone 4th order IMD products	$ 3*fx_{low} - 1*fx_{high} $	$ 3*fx_{high} - 1*fx_{low} $	$ 3*fy_{low} - 1*fx_{high} $	$ 3*fy_{high} - 1*fx_{low} $
IMD frequency limits (MHz)	2510	2785	5925	6150
Two-tone 4th order IMD products	$ 3*fx_{low} + 1*fx_{low} $	$ 3*fx_{high} + 1*fx_{high} $	$ 3*fy_{low} + 1*fx_{low} $	$ 3*fy_{high} + 1*fx_{high} $
IMD frequency limits (MHz)	7700	7975	9420	9645
Two-tone 4th order IMD products	$ 2*fx_{low} - 2*fx_{high} $	$ 2*fx_{high} - 2*fx_{low} $	$ 2*fx_{low} + 2*fx_{low} $	$ 2*fx_{high} + 2*fx_{high} $
IMD frequency limits (MHz)	1820	1570	8560	8810
Two-tone 5th order IMD products	$ fx_{low} - 4*fy_{high} $	$ fx_{high} - 4*fy_{low} $	$ fy_{low} - 4*fx_{high} $	$ fy_{high} - 4*fx_{low} $
IMD frequency limits (MHz)	8770	8495	4570	4220
Two-tone 5th order IMD products	$ 2*fx_{low} - 3*fy_{high} $	$ 2*fx_{high} - 3*fy_{low} $	$ 2*fy_{low} - 3*fx_{high} $	$ 2*fy_{high} - 3*fx_{low} $
IMD frequency limits (MHz)	4440	4140	215	110
Two-tone 5th order IMD products	$ fx_{low} + 4*fy_{low} $	$ fx_{high} + 4*fy_{high} $	$ fy_{low} + 4*fx_{low} $	$ fy_{high} + 4*fx_{high} $
IMD frequency limits (MHz)	11990	12265	9410	9760
Two-tone 5th order IMD products	$ 2*fx_{low} + 3*fy_{low} $	$ 2*fx_{high} + 3*fy_{high} $	$ 2*fy_{low} + 3*fx_{low} $	$ 2*fy_{high} + 3*fx_{high} $
IMD frequency limits (MHz)	11130	11430	10270	10595

Based on Table 6.53.2.1-1, it can be seen that IMD4 may fall into band n3 DL range.

Table 6.53.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.53.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n3A-n38A	E-UTRA Band 1, 5, 8, 20, 27, 28, 31, 32, 33, 34, 40, 43, 50, 51, 65, 67, 68, 72, 74, 75, 76	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA band 3	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA band 22, 42, 52	F_{DL_low}	-	F_{DL_high}	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3
	Frequency range	2620	-	2645	-15.5	5
	Frequency range	2645	-	2690	-40	1

NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2 \text{ MHz} + N \times L_{CRB} \times RB_{size} \text{ kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.

NOTE 13: This requirement applies for 5, 10, 15 and 20 MHz NR channel bandwidth allocated within 1744.9 MHz and 1784.9 MHz.

NOTE 15: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

NOTE 22: This requirement is applicable for power class 3 UE for any channel bandwidths within the range 2570 - 2615 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 2605.5 - 2607.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 2597 - 2605 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB. For power class 2 UE for any channel bandwidths within the range 2570 - 2615 MHz, NS_44 shall apply. For power class 2 or 3 UE for carriers with channel bandwidth overlapping the frequency range 2615 - 2620 MHz the requirement applies with the maximum output power configured to +19 dBm in the IE P-Max.

NOTE 26: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.

6.53.2.2 REFSENS requirements

Based on the co-existence study, it is seen that IMD4 could potentially desensitize B3 DL carrier. Therefore, MSD value and test configuration need to be defined. It is proposed to re-use the same MSD value of DC_3A_n38A combination for IMD4, i.e. 8.2 dB.

Table 6.53.2.2-1: MSD due to IMD4 issue

Operating band / Channel bandwidth / N _{RB} / Duplex mode								Source of IMD
CA Configuration	Operating band	UL F _c (MHz)	UL/DL BW (MHz)	UL C _{LRB}	DL F _c (MHz)	MSD (dB)	Duplex mode	
CA_n3A-n38A	n3	1713	5	25	1808	8.2	FDD	IMD4
	n38	2617	5	25	2617	N/A	TDD	N/A

6.54 CA_n2-n66

6.54.1 Common for 1 band UL and 2 bands UL CA

6.54.1.1 Operating bands for CA

Table 6.54.1.1-1: CA band combination of band n2+n66

NR Band	Uplink (UL) band		Duplex mode	
	BS receive / UE transmit			
	F _{UL_low} – F _{UL_high}			
n2	1850 MHz	– 1910 MHz	FDD	
n66	1710 MHz	– 1780 MHz	FDD	

6.54.1.2 Channel bandwidths per operating band for CA

Table 6.54.1.2-1: Supported bandwidths per CA band combination of band n2+n66

NR CA configuration	NR Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Maximum Aggregate bandwidth [MHz]	BCS
CA_n2A-n66A	-	n2	15	Yes	Yes	Yes	Yes									60	0
			30		Yes	Yes	Yes										
			60		Yes	Yes	Yes										
		n66	15	Yes	Yes	Yes	Yes			Yes							
			30		Yes	Yes	Yes			Yes							
			60		Yes	Yes	Yes			Yes							

6.54.1.3 UE co-existence studies

Table 6.54.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n2-n66.

Table 6.54.1.3-1: Impact of UL/DL Harmonic

					2 nd Harmonic		3 rd Harmonic		4 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n2	1850	1910	1930	1990	3700	3820	5550	5730	7400	7640
n66	1710	1780	2110	2200	3420	3560	5130	5340	6840	7120

Based on the table above, there is no harmonic relation.

Table 6.54.1.3-2: Impact of UL/DL Harmonic mixing

					2 nd Harmonic		3 rd Harmonic		4 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n2	1850	1910	1930	1990	3860	3980	5790	5970	7720	7960
n66	1710	1780	2110	2200	4220	4400	6330	6600	8440	8800

Based on above tables, there is no harmonic mixing relation.

6.54.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n2-n66, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are given in tables below. For this combination, the results are mainly reused from CA_2_66.

Table 6.54.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n2-n66	n2	0.5
	n66	0.5

Table 6.54.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,C}$ [dB]
CA_n2-n66	n2	0.3
	n66	0.3

6.54.1.5 REFSENS requirements

There are no specific REFSENS requirements for 1 band UL.

6.55 CA n5-n66

6.55.1 Common for 1 band UL and 2 bands UL CA

6.55.1.1 Operating bands for CA

Table 6.55.1.1-1: CA band combination of band n5+n66

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode		
	BS receive / UE transmit		BS transmit / UE receive				
	F_{UL_low} – F_{UL_high}		F_{DL_low} – F_{DL_high}				
n5	824 MHz	–	849 MHz	869MHz	–	894 MHz	FDD
n66	1710 MHz	–	1780 MHz	2110 MHz	–	2200 MHz	FDD

6.55.1.2 Channel bandwidths per operating band for CA

Table 6.55.1.2-1: Supported bandwidths per CA band combination of band n5+n66

NR CA configuration	NR Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Maximum Aggregated bandwidth [MHz]	BCS
CA_n5A-n66A	CA_n5A-n66A	n5	15	Yes	Yes	Yes	Yes									60	0
			30		Yes	Yes	Yes										
			60														
		n66	15	Yes	Yes	Yes	Yes			Yes						60	0
			30		Yes	Yes	Yes			Yes							
			60		Yes	Yes	Yes			Yes							

6.55.1.3 UE co-existence studies

Table 6.55.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n5-n66.

Table 6.55.1.3-1: Impact of UL/DL Harmonic

-	-	-	-	-	2nd Harmonic		3rd Harmonic		4th Harmonic	
<u>Band</u>	<u>UL Low Band Edge</u>	<u>UL High Band Edge</u>	<u>DL Low Band Edge</u>	<u>DL High Band Edge</u>	<u>UL Low Band Edge</u>	<u>UL High Band Edge</u>	<u>UL Low Band Edge</u>	<u>UL High Band Edge</u>	<u>UL Low Band Edge</u>	<u>UL High Band Edge</u>

<u>n5</u>	824	849	869	894	<u>1648</u>	<u>1698</u>	<u>2472</u>	<u>2547</u>	<u>3296</u>	<u>3396</u>
<u>n5</u>	1710	1780	2110	2200	<u>3420</u>	<u>3560</u>	<u>5130</u>	<u>5340</u>	<u>6840</u>	<u>7120</u>

Based on the table above, there is no harmonic relation.

Table 6.55.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic		3rd Harmonic		4th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n5	824	849	869	894	1738	1788	2607	2682	3476	3576
n66	1710	1780	2110	2200	4220	4400	6330	6600	8440	8800

Based on above tables, there is no harmonic mixing relation.

6.55.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n5-n66, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are given in tables below. For this combination, the results are mainly reused values from CA_5-66.

Table 6.55.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n5-n66	n5	0.3
	n66	0.3

Table 6.55.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n5-n66	n5	0
	n66	0

6.55.1.5 REFSENS requirements

There are no specific REFSENS requirements for 1 band UL.

6.55.2 Specific for 2 bands UL CA

6.55.2.1 UE co-existence studies

Table 6.55.2.1-1 lists Band n5 + Band n66 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.55.2.1-1: Band n5 and Band n66 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_high
----------------	--------	---------	---------

UL frequency (MHz)	824	849	1710	1780
2 nd harmonics frequency limits	2*fx_low	2*fx_high	2*fy_low	2*fy_high
2 nd harmonics frequency limits (MHz)	1648	1698	3420	3560
3 rd harmonics frequency limits	3*fx_low	3*fx_high	3*fy_low	3*fy_high
3 rd harmonics frequency limits (MHz)	2472	2547	5130	5340
4th harmonics frequency limits	4*fx_low	4*fx_high	4*fy_low	4*fy_high
4th harmonics frequency limits (MHz)	3296	3396	6840	7120
5th harmonics frequency limits	5*fx_low	5*fx_high	5*fy_low	5*fy_high
5th harmonics frequency limits (MHz)	4120	4245	8550	8900
2 nd order IMD products	fy_low - fx_high	fy_high - fx_low	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	861	956	2534	2629
Two-tone 3 rd order IMD products	2*fx_low - fy_high	2*fx_high - fy_low	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	132	12	2571	2736
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	3358	3478	4244	4409
Two-tone 4 th order IMD products	3*fx_low - 1*fy_high	3*fx_high - 1*fy_low	3*fy_low - 1*fx_high	3*fy_high - 1*fx_low
IMD frequency limits (MHz)	692	837	4281	4516
Two-tone 4 th order IMD products	3*fx_low + 1*fy_low	3*fx_high + 1*fy_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high
IMD frequency limits (MHz)	4182	4327	5954	6189
Two-tone 4 th order IMD products	2*fx_low - 2*fy_high	2*fx_high - 2*fy_low	2*fx_low + 2*fy_low	2*fx_high + 2*fy_high
IMD frequency limits (MHz)	1912	1722	5068	5258
Two-tone 5 th order IMD products	fx_low - 4*fy_high	fx_high - 4*fy_low	fy_low - 4*fx_high	fy_high - 4*fx_low
IMD frequency limits (MHz)	6296	5991	1686	1516
Two-tone 5 th order IMD products	2*fx_low - 3*fy_high	2*fx_high - 3*fy_low	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)	3692	3432	873	1088

It can be seen that the IMD2 and IMD5 of the dual UL may fall into the DL frequency range of Band n5.

Table 6.55.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.55.2.1-2: Protected bands for the 2UL bands CA configuration

NOTE: All the tables mentioned in the note of above table are specified in TS38.101-1.

6.55.2.2 REFSENS requirements

Because of 2nd and 5th IMD issue, the MSD requirements are shown below referring to DC_5_n66 or DC_66_n5.

Table 6.55.2.2-1: 2DL/2UL interband Reference sensitivity QPSK $P_{REFSENS}$ and uplink/downlink configurations

Band / Channel bandwidth / N_{RB} / Duplex mode								Source of IMD
NR CA Configuration	NR band	UL F_c (MHz)	UL/DL BW (MHz)	UL C_{LRB}	DL F_c (MHz)	MSD (dB)	Duplex mode	
CA_n5A-n66A	n5	838	5	25	883	30	FDD	IMD2 ⁴
	n66	1721	5	25	2121	N/A	FDD	N/A

Note 4: This band is subject to IMD5 also which MSD is not specified.

6.56 CA_n2-n78

6.56.1 Common for 1 band UL and 2 bands UL CA

6.56.1.1 Operating bands for CA

Table 6.56.1-1: CA band combination of band n38 + n66

NR CA Band Combination	NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
		BS receive / UE transmit			BS transmit / UE receive				
		$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$				
CA_n2-n78	n2	1850 MHz	–	1910 MHz	1930 MHz	–	1990 MHz	FDD	
	n78	3300 MHz	–	3800 MHz	3300 MHz	–	3800 MHz	TDD	

6.56.1.2 Channel bandwidths per operating band for CA

Table 8.x.2-1: Supported bandwidths per CA band combination of band n2+n78

NR CA configuration / Bandwidth combination set [MHz]																
NR CA configuration	UL configuration	NR Band	SCS (kHz)	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n2A-n78A	CA_n2A-n78A	n2	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
		n78	15		Yes											
			30		Yes											
			60		Yes											
CA_n2A-n78(2A)	CA_n2A-n78A	n2	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
		n78	See CA_n78(2A) Bandwidth Combination Set 1 in Table 5.5A.2-1													

6.56.1.3 Co-existence studies

Table 6.56.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n2-n78.

Table 6.56.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		nth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n2	1850	1910	1930	1990	3700	3820	5550	5730		
n78	3300	3800	3300	3800	6600	7600	9900	11400		

Based on above table, the 2nd harmonic of band n2 falls into the DL of band n78.

Table 6.56.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic		3rd Harmonic		mth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n2	1850	1910	1930	1990	3860	3980	5790	5970		
n78	3300	3800	3300	3800	6600	7600	9900	11400		

Based on above table, there is no harmonics mixing issue for the band combination of n2 and n78.

6.56.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n2-n78, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.56.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n2-n78	n2	0.6
	n78	0.8

Table 6.56.1.4-2: ΔR_{IB}

Inter-band CA Configuration	NR Band	ΔR_{IB} [dB]
CA_n2-n78	n2	0.2
	n78	0.5

6.56.1.5 REFSENs requirements

Reference sensitivity exceptions due to UL harmonic for the CA combination can reuse the MSD value from DC_2A_n78A.

Reference sensitivity exceptions are specified in Table 6.56.1.5-1 with uplink configuration specified in Table 6.56.1.5-2.

Table 6.56.1.5-1: Reference sensitivity exceptions due to UL harmonic for NR CA FR1

2	n78 ^{1,2}		23.9	22.1	20.9			17.9	16.8	16.0	14.8	14.3	13.8
n78 ³			1.1	0.8	0.3								
NOTE 1: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (lower) band for which the 2nd transmitter harmonic is within the downlink transmission bandwidth of a victim (higher) band and a range ΔF_{HD} above and below the edge of this downlink transmission bandwidth. The value ΔF_{HD} depends on the band combination: $\Delta F_{HD} = 10$ MHz for CA_n1-n77, CA_n2-n78, CA_n3-n77, CA_n3-n78, CA_n2-n48, CA_n48-n66.													
NOTE 2: The requirements should be verified for UL NR-ARFCN of the aggressor (lower) band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.2 \rfloor$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{HB} carrier frequency in the victim (higher) band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the lower band.													
NOTE 3: The requirements are only applicable to channel bandwidths no larger than 20 MHz and with a carrier frequency at $\pm(20 + BW_{Channel}^{HB} / 2)$ MHz offset from $2f_{UL}^{LB}$ in the victim (higher band) with $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$, where $BW_{Channel}^{LB}$ and $BW_{Channel}^{HB}$ are the channel bandwidths configured in the aggressor (lower) and victim (higher) bands in MHz, respectively.													

Table 6.56.1.5-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for NR CA, FR1

NR Band / Channel bandwidth of the high band													
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n2	n78		25	36	50			50	50	50	50	50	50

6.56.2 Specific for 2 bands UL CA

6.56.2.1 UE co-existence studies

Table 6.56.2.1-1 gives IMD interference analysis for CA_n2-n78 with 2 ULs.

Table 6.56.2.1-1: Harmonic and IMD analysis

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	3300	3800	1850	1910
Two tone 2 nd order IMD products	fy_low – fx_high	fy_high – fx_low	fx_low + fy_low	fx_high + fy_high
IMD frequency limits (MHz)	1950	1390	5150	5710
Two-tone 3 rd order IMD products	2*fx_low – fy_high	2*fx_high – fy_low	2*fy_low – fx_high	2*fy_high – fx_low
IMD frequency limits (MHz)	4690	5750	100	520
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	8450	9510	7000	7620
Two-tone 4 th order IMD products	3*fx_low – fy_high	3*fx_high – fy_low	3*fy_low – fx_high	3*fy_high – fx_low
IMD frequency limits (MHz)	7990	9550	1750	2430
Two-tone 4 th order IMD products	3*fx_low + fy_low	3*fx_high + fy_high	3*fy_low + fx_low	3*fy_high + fx_high
IMD frequency limits (MHz)	11750	13310	8850	9030
Two-tone 4 th order IMD products	2*fy_low – 2*fx_high	2*fy_high – 2*fx_low	2*fx_low + 2*fy_low	2*fx_high + 2*fy_high
IMD frequency limits (MHz)	3900	2780	10300	11420

Two-tone 5 th order IMD products	$ 4*fx_{low} - fy_{high} $	$ 4*fx_{high} - fy_{low} $	$4*fy_{low} - fx_{high}$	$4*fy_{high} - fx_{low}$
IMD frequency limits (MHz)	11290	13350	3600	4340
Two-tone 5 th order IMD products	$4*fx_{low} + fy_{low}$	$4*fx_{high} + fy_{high}$	$4*fy_{low} + fx_{low}$	$4*fy_{high} + fx_{high}$
IMD frequency limits (MHz)	15050	17110	10700	11440
Two-tone 5 th order IMD products	$ 3*fx_{low} - 2*fy_{high} $	$ 3*fx_{high} - 2*fy_{low} $	$3*fy_{low} - 2*fx_{high}$	$3*fy_{high} - 2*fx_{low}$
IMD frequency limits (MHz)	6080	7700	2050	870
Two-tone 5 th order IMD products	$2*fx_{low} + 3*fy_{low}$	$2*fx_{high} + 3*fy_{high}$	$2*fy_{low} + 3*fx_{low}$	$2*fy_{high} + 3*fx_{high}$
IMD frequency limits (MHz)	12150	13330	13600	15220

Based on the table 6.2.x.1-1, two-tone 4th order IMD products may fall into the own Rx Band or Band n2.

Table 6.56.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.56.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n2-n78	E-UTRA Band 5, 7, 12, 13, 26, 28, 41, 66	F _{DL_low}	-	F _{DL_high}	-50	1	
	E-UTRA Band 2, 25	F _{DL_low}	-	F _{DL_high}	-50	1	4

6.56.2.2 REFSENS requirements

Based on the table 6.2.x.1-1, two-tone 4th order IMD products may fall into the own Rx Band of Band n2. The MSD value can be reused from DC 2A n78A.

Table 6.56.2.1-1: 2DL/2UL interband Reference sensitivity QPSK $P_{REFSENS}$ and uplink/downlink configurations

Band / Channel bandwidth / N _{RB} / Duplex mode								Source of IMD
NR CA Configuration	NR band	UL F _c (MHz)	UL/DL BW (MHz)	UL C _{LRB}	DL F _c (MHz)	MSD (dB)	Duplex mode	
CA_n2A-n78A CA_n2A-n78(2A)	n2	1855	5	25	1935	26	FDD	IMD2 ⁴
	n78	3790	10	50	3790	28.7 ⁵		

6.57 CA_n7-n25

6.57.1 Common for 1 band UL and 2 bands UL CA

6.57.1.1 Operating bands for CA

Table 6.57.1-1: CA band combination of band n7 + n25

NR CA Band Combination	NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
		BS receive / UE transmit			BS transmit / UE receive				
		$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$				
CA_n7-n25	n7	2500 MHz – 2570 MHz			2620 MHz – 2690 MHz			FDD	
	n25	1850 MHz – 1915 MHz			1930 MHz – 1995 MHz			FDD	

6.57.1.2 Channel bandwidths per operating band for CA

Table 8.x.2-1: Supported bandwidths per CA band combination of band n7+n66

NR CA configuration / Bandwidth combination set [MHz]																
NR CA configuration	UL configuration	NR Band	SCS (kHz)	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n7A-n25A	CA_n7A-n25A	n7	15	Yes						0						
			30		Yes	Yes	Yes	Yes	Yes	Yes						
			60		Yes	Yes	Yes	Yes	Yes	Yes						
		n25	15	Yes												
			30		Yes	Yes	Yes	Yes	Yes	Yes						
			60		Yes	Yes	Yes	Yes	Yes	Yes						
CA_n7A-n25(2A)	CA_n7A-n25A	n7	15	Yes						0						
			30		Yes	Yes	Yes	Yes	Yes	Yes						
			60		Yes	Yes	Yes	Yes	Yes	Yes						
		n25	See CA_n25(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1													
CA_n7(2A)-n25A	CA_n7A-n25A	n25	15	Yes						0						
			30		Yes	Yes	Yes	Yes	Yes	Yes						
			60		Yes	Yes	Yes	Yes	Yes	Yes						
		n7	See CA_7(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1													
CA_n7(2A)-n25(2A)	CA_n7A-n25A	n7	See CA_7(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1													0
		n25	See CA_25(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1													

6.57.1.3 Co-existence studies

Table 6.57.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n7-n25.

Table 6.57.1.3-1: Impact of UL/DL Harmonic

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2nd Harmonic			3rd Harmonic			nth Harmonic		
					UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge
n7	2500	2570	2620	2690	5000	5140	7500	7710					
n25	1850	1915	1930	1995	3700	3830	5550	5745					

Based on above table, there is no harmonic issue for the combination.

Table 6.57.1.3-2: Impact of UL/DL Harmonic mixing

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2nd Harmonic		3rd Harmonic		mth Harmonic	
	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n7	2500	2570	2620	2690	5240	5380	7860	8070		
n25	1850	1915	1930	1995	3860	3990	5790	5985		

Based on above table, there is no harmonics mixing issue for the band combination of n7 and n25.

6.57.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n7-n25, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.57.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n7-n25	n7	0.5
	n25	0.5

Table 6.57.1.4-2: ΔR_{IB}

Inter-band CA Configuration	NR Band	ΔR_{IB} [dB]
CA_n7-n25	n7	0
	n25	0

6.57.1.5 REFSENs requirements

There is neither harmonics mixing issue nor harmonics issue for the band combination of n7 and n25.

6.57.2 Specific for 2 bands UL CA

6.57.2.1 UE co-existence studies

Table 6.57.2.1-1 gives IMD interference analysis for CA_n7-n25 with 2 ULs.

Table 6.57.2-1: Harmonic and IMD analysis

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	1850	1915	2500	2570
Two tone 2 nd order IMD products	fy_low – fx_high	fy_high – fx_low	fx_low + fy_low	fx_high + fy_high
IMD frequency limits (MHz)	585	720	4350	4485
Two-tone 3 rd order IMD products	2*fx_low – fy_high	2*fx_high – fy_low	2*fy_low – fx_high	2*fy_high – fx_low
IMD frequency limits (MHz)	1130	1330	3085	3290
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high

IMD frequency limits (MHz)	6200	6400	6850	7055
Two-tone 4 th order IMD products	$ 3*fx_{low} - fy_{high} $	$ 3*fx_{high} - fy_{low} $	$3*fy_{low} - fx_{high}$	$3*fy_{high} - fx_{low}$
IMD frequency limits (MHz)	2980	3245	5585	5860
Two-tone 4 th order IMD products	$3*fx_{low} + fy_{low}$	$3*fx_{high} + fy_{high}$	$3*fy_{low} + fx_{low}$	$3*fy_{high} + fx_{high}$
IMD frequency limits (MHz)	8050	8315	9350	9560
Two-tone 4 th order IMD products	$2*fy_{low} - 2*fx_{high}$	$2*fy_{high} - 2*fx_{low}$	$2*fx_{low} + 2*fy_{low}$	$2*fx_{high} + 2*fy_{high}$
IMD frequency limits (MHz)	1170	1440	8700	8970
Two-tone 5 th order IMD products	$ 4*fx_{low} - fy_{high} $	$ 4*fx_{high} - fy_{low} $	$4*fy_{low} - fx_{high}$	$4*fy_{high} - fx_{low}$
IMD frequency limits (MHz)	4830	5160	8085	8430
Two-tone 5 th order IMD products	$4*fx_{low} + fy_{low}$	$4*fx_{high} + fy_{high}$	$4*fy_{low} + fx_{low}$	$4*fy_{high} + fx_{high}$
IMD frequency limits (MHz)	9900	10230	11850	12195
Two-tone 5 th order IMD products	$ 3*fx_{low} - 2*fy_{high} $	$ 3*fx_{high} - 2*fy_{low} $	$3*fy_{low} - 2*fx_{high}$	$3*fy_{high} - 2*fx_{low}$
IMD frequency limits (MHz)	410	745	3670	4010
Two-tone 5 th order IMD products	$2*fx_{low} + 3*fy_{low}$	$2*fx_{high} + 3*fy_{high}$	$2*fy_{low} + 3*fx_{low}$	$2*fy_{high} + 3*fx_{high}$
IMD frequency limits (MHz)	11200	11540	10550	10885

Based on the table 6.1.x.4-1, there is no IMD issue for the combination.

Table 6.57.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.57.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n7-n25	E-UTRA Band 4, 5, 7, 10, 12, 13, 14, 17, 26, 27, 28, 29, 30, 42, 66, 85 NR Band n78	F _{DL_low}	-	F _{DL_high}	-50	1
	E-UTRA Band 43	F _{DL_low}	-	F _{DL_high}	-50	1
	E-UTRA Band 2, 25	F _{DL_low}	-	F _{DL_high}	-50	1
	Frequency range	2570	-	2575	1.6	5
	Frequency range	2575	-	2595	-15.5	5
	Frequency range	2595	-	2620	-40	1
NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of (2 MHz + N x LCRB x 180kHz), where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.						
NOTE 4:	These requirements also apply for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.					
NOTE 7:	For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.					
NOTE 18:	This requirement is applicable for any channel bandwidths within the range 2500 – 2570 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 2560.5 - 2562.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 2552 – 2560 MHz the requirement is applicable only for an uplink transmission					

bandwidth less than or equal to 54 RB.
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6.57.2.2 REFSENS requirements

There is no IMD issue for the band combination of n7 and n25

6.58 CA_n25-n66

6.58.1 Common for 1 band UL and 2 bands UL CA

6.58.1.1 Operating bands for CA

Table 6.58.1-1: CA band combination of band n25 + n66

NR CA Band Combination	NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode
		BS receive / UE transmit		F _{UL_low} – F _{UL_high}	BS transmit / UE receive		F _{DL_low} – F _{DL_high}	
		n25	1850 MHz – 1915 MHz	1930 MHz – 1995 MHz	n66	1710 MHz – 1780 MHz	2110 MHz – 2200 MHz	
CA_n25-n66	n25	1850 MHz – 1915 MHz	1930 MHz – 1995 MHz	FDD	n66	1710 MHz – 1780 MHz	2110 MHz – 2200 MHz	FDD

6.58.1.2 Channel bandwidths per operating band for CA

Table 6.x.1.2-1: Supported bandwidths per CA band combination of band n25+n66

NR CA configuration / Bandwidth combination set [MHz]																0
NR CA configuration	UL configuration	NR Band	SCS (kHz)	5	10	15	20	25	30	40	50	60	80	90	100	
CA_n25A-n66A	CA_n25 A-n66A	n25	15	Yes												
			30		Yes	Yes	Yes	Yes	Yes	Yes						
			60		Yes	Yes	Yes	Yes	Yes	Yes						
		n66	15	Yes	Yes	Yes	Yes		Yes	Yes						
			30		Yes	Yes	Yes		Yes	Yes						
			60		Yes	Yes	Yes		Yes	Yes						
CA_n25A-n66(2A)	CA_n25 A-n66A	n25	15	Yes						0						
			30		Yes	Yes	Yes	Yes	Yes	Yes						
			60		Yes	Yes	Yes	Yes	Yes	Yes						
		n66	15	Yes												
			30		Yes	Yes	Yes	Yes	Yes	Yes						
CA_n25(2A)-n66A	CA_n25 A-n66A	n25	See CA_n66(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1													0
		n66	15		Yes	Yes	Yes		Yes	Yes						
			30		Yes	Yes	Yes		Yes	Yes						
			60		Yes	Yes	Yes		Yes	Yes						
CA_n25(2A)-n66(2A)	CA_n25 A-n66A	n25	See CA_n25(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1													0
		n66	See CA_n66(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1													

6.58.1.3 Co-existence studies

Table 6.58.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n25-n66.

Table 6.58.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		nth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n25	1850	1915	1930	1995	3700	3830	5550	5745		
n66	1710	1780	2110	2200	3420	3560	5130	5340		

Based on above table, there is no harmonic issue for the band combination of n25 and n66.

Table 6.58.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic			3rd Harmonic		mth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	
n25	1850	1915	1930	1995	3860	3990	5790	5985			
n66	1710	1780	2110	2200	4220	4400	6330	6600			

Based on above table, there is no harmonics mixing issue for the band combination of n25 and n66.

6.58.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n25-n66, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.58.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n25-n66	n25	0.5
	n66	0.5

Table 6.58.1.4-2: ΔR_{IB}

Inter-band CA Configuration	NR Band	ΔR_{IB} [dB]
CA_n25-n66	n25	0.3
	n66	0.3

6.58.1.5 REFSENs requirements

There is neither harmonic issue nor harmonics mixing issue for the band combination of n25 and n66.

6.58.2 Specific for 2 bands UL CA

6.58.2.1 UE co-existence studies

Table 6.58.2.1-1 gives IMD interference analysis for CA_n25-n66 with 2 ULs.

Table 6.58.2.1-1: Harmonic and IMD analysis

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	1710	1780	1850	1915

Two tone 2 nd order IMD products	$fy_{low} - fx_{high}$	$fy_{high} - fx_{low}$	$fx_{low} + fy_{low}$	$fx_{high} + fy_{high}$
IMD frequency limits (MHz)	70	205	3560	3695
Two-tone 3 rd order IMD products	$ 2*fx_{low} - fy_{high} $	$ 2*fx_{high} - fy_{low} $	$2*fy_{low} - fx_{high}$	$2*fy_{high} - fx_{low}$
IMD frequency limits (MHz)	1505	1710	1920	2120
Two-tone 3 rd order IMD products	$2*fx_{low} + fy_{low}$	$2*fx_{high} + fy_{high}$	$2*fy_{low} + fx_{low}$	$2*fy_{high} + fx_{high}$
IMD frequency limits (MHz)	5270	5475	5410	5610
Two-tone 4 th order IMD products	$ 3*fx_{low} - fy_{high} $	$ 3*fx_{high} - fy_{low} $	$3*fy_{low} - fx_{high}$	$3*fy_{high} - fx_{low}$
IMD frequency limits (MHz)	3215	3490	3770	4035
Two-tone 4 th order IMD products	$3*fx_{low} + fy_{low}$	$3*fx_{high} + fy_{high}$	$3*fy_{low} + fx_{low}$	$3*fy_{high} + fx_{high}$
IMD frequency limits (MHz)	6980	7255	7260	7455
Two-tone 4 th order IMD products	$2*fy_{low} - 2*fx_{high}$	$2*fy_{high} - 2*fx_{low}$	$2*fx_{low} + 2*fy_{low}$	$2*fx_{high} + 2*fy_{high}$
IMD frequency limits (MHz)	140	410	7120	7390
Two-tone 5 th order IMD products	$ 4*fx_{low} - fy_{high} $	$ 4*fx_{high} - fy_{low} $	$4*fy_{low} - fx_{high}$	$4*fy_{high} - fx_{low}$
IMD frequency limits (MHz)	4925	5270	5620	5950
Two-tone 5 th order IMD products	$4*fx_{low} + fy_{low}$	$4*fx_{high} + fy_{high}$	$4*fy_{low} + fx_{low}$	$4*fy_{high} + fx_{high}$
IMD frequency limits (MHz)	8690	9035	9110	9440
Two-tone 5 th order IMD products	$ 3*fx_{low} - 2*fy_{high} $	$ 3*fx_{high} - 2*fy_{low} $	$3*fy_{low} - 2*fx_{high}$	$3*fy_{high} - 2*fx_{low}$
IMD frequency limits (MHz)	1300	1640	1990	2325
Two-tone 5 th order IMD products	$2*fx_{low} + 3*fy_{low}$	$2*fx_{high} + 3*fy_{high}$	$2*fy_{low} + 3*fx_{low}$	$2*fy_{high} + 3*fx_{high}$
IMD frequency limits (MHz)	8970	9305	8830	9170

Based on the table 6.2.x.1-1, the MSD issue due to IMD is as below,

- Two-tone 3rd order IMD products may fall into the own Rx Band of Band n25 and n66.
- Two-tone 5th order IMD products may fall into the own Rx Band of Band n25 and n66.

Table 6.58.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.58.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA Configuration	Spurious emission					NOTE
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	
CA_n25-n66	E-UTRA Band 4, 5, 7, 10, 12, 13, 14, 17, 24, 26, 27, 28, 29, 30, 38, 41, 50, 51, 53, 66, 70, 71, 74, 85 NR Band n78	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 42, 43, 48	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 2, 25	F_{DL_low}	-	F_{DL_high}	-50	1

NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1

	MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2 \text{ MHz} + N \times \text{LCRB} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.
NOTE 4:	These requirements also apply for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

6.58.2.2 REFSENS requirements

Based on the co-existence study, there are IMD3 and IMD5 issues for the combination. The MSD value can be reused from DC_25A_n66A.

Table 6.58.2.1-1: 2DL/2UL interband Reference sensitivity QPSK P_{REFSENS} and uplink/downlink configurations

Band / Channel bandwidth / N_{RB} / Duplex mode								Source of IMD
NR CA Configuration	NR band	UL F_c (MHz)	UL/DL BW (MHz)	UL C_{LRB}	DL F_c (MHz)	MSD (dB)	Duplex mode	
CA_n25A-n66A CA_n25A-n66(2A) CA_n25(2A)-n66A CA_n25(2A)-n66(2A)	n66	1775	5	25	2175	N/A	FDD	N/A
	n25	1855	5	25	1935	20	FDD	IMD3
	n66	1712.5	5	25	2112.5	23	FDD	IMD3
	n25	1912.5	5	25	1992.5	N/A	FDD	N/A
	n66	1750	5	25	2150	4	FDD	IMD5
	n25	1883.3	5	25	1963.3	N/A	FDD	N/A

6.59 CA_n25-n78

6.59.1 Common for 1 band UL and 2 bands UL CA

6.59.1.1 Operating bands for CA

Table 6.59.1-1: CA band combination of band n25 + n78

NR CA Band Combination	NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode
		BS receive / UE transmit		$F_{\text{UL_low}} - F_{\text{UL_high}}$	BS transmit / UE receive		$F_{\text{DL_low}} - F_{\text{DL_high}}$	
		n25	1850 MHz – 1915 MHz	1930 MHz – 1995 MHz	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	
CA_n25-n78	n25	1850 MHz	–	1915 MHz	1930 MHz	–	1995 MHz	FDD
CA_n25-n78	n78	3300 MHz	–	3800 MHz	3300 MHz	–	3800 MHz	TDD

6.59.1.2 Channel bandwidths per operating band for CA

Table 6.59.1.2-1: Supported bandwidths per CA band combination of band n25+n78

NR CA configuration / Bandwidth combination set [MHz]																
NR CA configuration	UL configuration	NR Band	SCS (kHz)	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n25A-n78A	CA_n25	n25	15	Yes						0						
			30	Yes												
			60	Yes												
	A-n78A	n78	15	Yes												
			30	Yes												
			60	Yes												

CA_n25A-n78(2A)	CA_n25 A-n78A	n25	15	Yes	Yes	Yes	Yes	Yes	Yes						0	
			30		Yes	Yes	Yes	Yes	Yes							
			60		Yes	Yes	Yes	Yes	Yes							
		n78	See CA_n78(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1													
CA_n25(2A)-n78A	CA_n25 A-n78A	n25	See CA_n25(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1													
		n78	15		Yes	Yes	Yes	Yes	Yes						0	
			30		Yes											
			60		Yes											
CA_n25(2A)-n78(2A)	CA_n25 A-n78A	n25	See CA_n25(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1													
		n78	See CA_n78(2A) Bandwidth Combination Set 1 in Table 5.5A.2-1													

6.59.1.3 Co-existence studies

Table 6.59.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n25-n78.

Table 6.59.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		nth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n25	1850	1915	1930	1995	3700	3830	5550	5745		
n78	3300	3800	3300	3800	6600	7600	9900	11400		

Based on above table, the 2nd harmonic of band n2 falls into the DL of band n78.

Table 6.59.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic		3rd Harmonic		mth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n25	1850	1915	1930	1995	3860	3990	5790	5985		
n78	3300	3800	3300	3800	6600	7600	9900	11400		

Based on above table, there is no harmonics mixing issue for the band combination of n25 and n78.

6.59.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n25-n78, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.59.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n25-n78	n25	0.6
	n78	0.8

Table 6.59.1.4-2: ΔR_{IB}

Inter-band CA Configuration	NR Band	ΔR_{IB} [dB]
CA_n25-n78	n25	0.2
	n78	0.5

6.59.1.5 REFSENs requirements

Reference sensitivity exceptions due to UL harmonic for the CA combination can reuse the MSD value from DC_2A_n78A.

Reference sensitivity exceptions are specified in Table 6.59.1.5-1 with uplink configuration specified in Table 6.59.1.5-2.

Table 6.59.1.5-1: Reference sensitivity exceptions due to UL harmonic for NR CA FR1

MSD due to harmonic exception for the DL band													
UL band	DL band	5 MHz dB	10 MHz dB	15 MHz dB	20 MHz dB	25 MHz dB	30 MHz dB	40 MHz dB	50 MHz dB	60 MHz dB	80 MHz dB	90 MHz dB	100 MHz dB
25	n78 ^{1,2}		23.9	22.1	20.9			17.9	16.8	16.0	14.8	14.3	13.8
	n78 ³		1.1	0.8	0.3								

NOTE 1: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (lower) band for which the 2nd transmitter harmonic is within the downlink transmission bandwidth of a victim (higher) band and a range ΔF_{HD} above and below the edge of this downlink transmission bandwidth. The value ΔF_{HD} depends on the band combination: $\Delta F_{HD} = 10$ MHz for CA_n1-n77, CA_n3-n77, CA_n3-n78, CA_n2-n48, CA_n25-n78, CA_n48-n66.

NOTE 2: The requirements should be verified for UL NR-ARFCN of the aggressor (lower) band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.2 \rfloor$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{HB} carrier frequency in the victim (higher) band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the lower band.

NOTE 3: The requirements are only applicable to channel bandwidths no larger than 20 MHz and with a carrier frequency at $\pm (20 + BW_{Channel}^{HB} / 2)$ MHz offset from $2f_{UL}^{LB}$ in the victim (higher band) with $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$, where $BW_{Channel}^{LB}$ and $BW_{Channel}^{HB}$ are the channel bandwidths configured in the aggressor (lower) and victim (higher) bands in MHz, respectively.

Table 6.59.1.5-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for NR CA, FR1

NR Band / Channel bandwidth of the high band													
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n25	n78		25	36	50			50	50	50	50	50	50

6.59.2 Specific for 2 bands UL CA

6.59.2.1 UE co-existence studies

Table 6.59.2.1-1 gives IMD interference analysis for CA_n25-n78 with 2 ULs.

Table 6.59.2.1-1: Harmonic and IMD analysis

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	3300	3800	1850	1915

Two tone 2 nd order IMD products	$fy_{low} - fx_{high}$	$fy_{high} - fx_{low}$	$fx_{low} + fy_{low}$	$fx_{high} + fy_{high}$
IMD frequency limits (MHz)	1950	1385	5150	5715
Two-tone 3 rd order IMD products	$ 2*fx_{low} - fy_{high} $	$ 2*fx_{high} - fy_{low} $	$2*fy_{low} - fx_{high}$	$2*fy_{high} - fx_{low}$
IMD frequency limits (MHz)	4685	-5750	-100	530
Two-tone 3 rd order IMD products	$2*fx_{low} + fy_{low}$	$2*fx_{high} + fy_{high}$	$2*fy_{low} + fx_{low}$	$2*fy_{high} + fx_{high}$
IMD frequency limits (MHz)	8450	9515	7000	7630
Two-tone 4 th order IMD products	$ 3*fx_{low} - fy_{high} $	$ 3*fx_{high} - fy_{low} $	$3*fy_{low} - fx_{high}$	$3*fy_{high} - fx_{low}$
IMD frequency limits (MHz)	7985	9550	1750	2445
Two-tone 4 th order IMD products	$3*fx_{low} + fy_{low}$	$3*fx_{high} + fy_{high}$	$3*fy_{low} + fx_{low}$	$3*fy_{high} + fx_{high}$
IMD frequency limits (MHz)	11750	13315	8850	9045
Two-tone 4 th order IMD products	$2*fy_{low} - 2*fx_{high}$	$2*fy_{high} - 2*fx_{low}$	$2*fx_{low} + 2*fy_{low}$	$2*fx_{high} + 2*fy_{high}$
IMD frequency limits (MHz)	3900	2770	10300	11430
Two-tone 5 th order IMD products	$ 4*fx_{low} - fy_{high} $	$ 4*fx_{high} - fy_{low} $	$4*fy_{low} - fx_{high}$	$4*fy_{high} - fx_{low}$
IMD frequency limits (MHz)	11285	13350	3600	4360
Two-tone 5 th order IMD products	$4*fx_{low} + fy_{low}$	$4*fx_{high} + fy_{high}$	$4*fy_{low} + fx_{low}$	$4*fy_{high} + fx_{high}$
IMD frequency limits (MHz)	15050	17115	10700	11460
Two-tone 5 th order IMD products	$ 3*fx_{low} - 2*fy_{high} $	$ 3*fx_{high} - 2*fy_{low} $	$3*fy_{low} - 2*fx_{high}$	$3*fy_{high} - 2*fx_{low}$
IMD frequency limits (MHz)	6070	7700	2050	855
Two-tone 5 th order IMD products	$2*fx_{low} + 3*fy_{low}$	$2*fx_{high} + 3*fy_{high}$	$2*fy_{low} + 3*fx_{low}$	$2*fy_{high} + 3*fx_{high}$
IMD frequency limits (MHz)	12150	13345	13600	15230

Based on the table 6.2.x.1-1, two-tone 4th order IMD products may fall into the own Rx Band of Band n25.

Table 6.59.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.59.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n25-n78	E-UTRA Band 5, 7, 12, 13, 25, 26, 28, 41, 66	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 2, 25	F_{DL_low}	-	F_{DL_high}	-50	1	4

NOTE 4: These requirements also apply for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

6.59.2.2 REFSENS requirements

Based on the table 6.2.x.1-1, two-tone 4th order IMD products may fall into the own Rx Band of Band n2. The MSD value can be reused from DC_2A_n78A.

Table 6.59.2.1-1: 2DL/2UL interband Reference sensitivity QPSK $P_{REFSENS}$ and uplink/downlink configurations

6.60 CA_n20-n75

6.60.1 Common for 1 band UL and 2 bands UL CA

6.60.1.1 Operating bands for CA

Table 6.60.1.1-1: CA band combination CA_n20A-n75A

NR CA Band Combination	NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
		BS receive / UE transmit		BS transmit / UE receive			
		$F_{UL_low} - F_{UL_high}$	$F_{DL_low} - F_{DL_high}$				
CA_n20-n75	n20	832 MHz – 862 MHz	791 MHz – 821 MHz			FDD	
	n75	N/A	1432 MHz – 1517 MHz			SDL	

6.60.1.2 Channel bandwidths per operating band for CA

Table 6.60.1.2-1: Supported bandwidths per CA band combination CA_n20A-n75A

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n20A-n75A	-	n20	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60													
		n75	15	Yes	Yes	Yes	Yes									
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									

6.60.1.3 Co-existence studies

Table 6.60.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n20-n75.

Table 6.60.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		4th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n20	832	862	791	821	1664	1724	2496	2586	3328	3448
n75	-	-	1432	1571						

Based on above table, there is no harmonics issue for the band combination of n20 and n75.

Table 6.60.1.3-2: Impact of UL/DL Harmonic mixing

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2nd Harmonic		3rd Harmonic		m th Harmonic	
	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n20	832	862	791	821	1582	1642	2373	2463		
n75			1432	1571	2864	3142	4296	4713		

Based on above table, there is no harmonics mixing issue for the band combination of n20 and n75.

6.60.1.4 $\Delta T_{IB,c}$ and ΔR_{IB} values

For CA_n20A-n75A, the $\Delta T_{IB,c}$ and ΔR_{IB} can follow the values of DC_20_n75. The values are given in the tables below.

Table 6.60.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n20-n75	n20	0.3

Table 6.60.1.4-2: ΔR_{IB}

Inter-band CA Configuration	NR Band	ΔR_{IB} [dB]
CA_n20-n75	n20	0

6.60.1.5 REFSENs requirements

There is no additional MSD requirement for CA_n20-n75. But the Reference sensitivity for CA_n20-n75 which includes SDL band is listed below.

Table 6.60.1.5-1: Reference sensitivity for SDL bands

NR Band/Channel bandwidth													
NR CA Configuration	NR band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	M	
			dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	
CA_n20A-n75A	n20	15	-97.0	-93.8	-91.0	-89.8							
		30		-94.1	-91.1	-90.0							
		60											
	n75	15	-100	-96.8	-95.0	-93.8							
		30		-97.1	-95.1	-94.0							
		60		-97.5	-95.4	-94.2							

NOTE 1: The transmitter shall be set to P_{UMAX} , as defined in subclause 6.2.4.
 NOTE 2: Four Rx antenna ports shall be the baseline for this operating band, except for two Rx vehicular UE.

6.61 CA_n78-n92

6.61.1 Common for 1 band UL and 2 bands UL

6.61.1.1 Operating bands for CA

Table 6.61.1.1-1: CA band combination of band n78+n92

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
	BS receive / UE transmit		BS transmit / UE receive			
	F_{UL_low} – F_{UL_high}	F_{DL_low} – F_{DL_high}	F_{DL_low} – F_{DL_high}	F_{DL_low} – F_{DL_high}		
n78	3300 MHz – 3800 MHz		3300 MHz – 3800 MHz		TDD	
n92	832 MHz – 862 MHz		1432 MHz – 1517 MHz		FDD	

6.61.1.2 Channel bandwidths per operating band for CA

Table 6.61.1.2-1: Supported bandwidths per CA band combination of band n78+n92

CA operating / channel bandwidth [MHz]																
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	80	90	100	Bandwidth combination set
CA_n78A-n92A	CA_n78A-n92A	n78	15		Yes	Yes	Yes			Yes	Yes					0
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	
		n92	15	Yes	Yes	Yes	Yes									
			30		Yes	Yes	Yes									
			60													
CA_n78(2A)-n92A	CA_n78A-n92A	n78	See CA_n78(2A) Bandwidth Combination Set 0 in Table 5.5A.2-1												0	
			Yes	Yes	Yes	Yes	Yes									
		n92		Yes	Yes	Yes	Yes									

6.61.1.3 UE co-existence studies

Table 6.61.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n78-n92.

Table 6.61.1.3-1: Impact of UL/DL Harmonic

					2nd Harmonic		3rd Harmonic		4th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n78	3300	3800	3300	3800	6600	7600	9900	11400	13200	15200
n92	832	862	1432	1517	1664	1724	2496	2586	3328	3448

Based on above table, the 4th harmonics of band n92 UL will fall into the band n78 Rx.

Table 6.61.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic		3rd Harmonic		mth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n78	3300	3800	3300	3800	6600	7600	9900	11400		
n92	832	862	1432	1517	2864	3034	4296	4551		

Based on above table, there is no harmonic mixing issue for the band combination of n92 and n78.

6.61.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n78-n92, the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 6.61.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n78-n92	n78	0.8
	n92	0.6

Table 6.61.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n78-n92	n78	0.5
	n92	0

6.61.1.5 REFSENS requirements

The specific MSD requirement can follow the requirements of CA_n20-n78 as defined in 6.49.1.5.

Table 6.61.1.5-1: Reference sensitivity exceptions due to UL harmonic for NR CA FR1

MSD due to harmonic exception for the DL band													
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
		dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
n92	n78 ^{4,5}	10.8	9.1	8				6	4.0	3.2	2.0	1.5	1.0

NOTE 4: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (lower) band for which the 4th transmitter harmonic is within the downlink transmission bandwidth of a victim (higher) band.

NOTE 5: The requirements should be verified for UL NR-ARFCN of a low band (superscript LB) such that

$$f_{UL}^{LB} = \left\lfloor f_{DL}^{HB} / 0.4 \right\rfloor 0.1 \text{ in MHz and } F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2 \text{ with } f_{DL}^{HB} \text{ the carrier frequency of a high band in MHz and } BW_{Channel}^{LB} \text{ the channel bandwidth configured in the low band.}$$

Table 6.61.1.5-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for NR CA, FR1

NR Band / Channel bandwidth of the high band													
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n92	n78		16	25	25			25	25	25	25	25	25

For CA configurations of both CA_n78A-n92A and CA_n78(2A)-n92A, the same requirements defined in this sub-clause apply.

6.61.1.6 Out-of-band blocking requirements

The combination is subject to be allowed for out-of-band blocking exceptions when the second order intermodulation product of the lower frequency band UL carrier and the CW interfering signal fully or partially overlaps with the higher frequency band DL carrier.

Table 6.61.1.6-1: CA band combination with exceptions allowed

CA band combination
CA_n78-n92

Table 6.61.1.6-2: Requirement for out-of-band blocking exceptions

Parameter	Unit	Level
P _{Interferer} (CW)	dBm	-44 ¹
NOTE 1: The requirement applies when $ f_{Interferer} \pm f_{UL}^{LB} - f_{DL}^{HB} \leq (BW_{UL}^{LB} + BW_{DL}^{HB})/2$, where f_{UL}^{LB} and f_{DL}^{HB} are the carrier frequencies for lower frequency band UL and higher frequency band DL, respectively. BW_{UL}^{LB} and BW_{DL}^{HB} are the channel bandwidths configured for lower frequency band UL carrier and higher frequency band DL carrier in MHz, respectively.		

6.61.2 Specific for 2 bands UL CA

6.61.2.1 UE co-existence studies

Band n78 +Band n92 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis can refer to table 6.49.2.1-1 for CA_n20-n78.

Based on abovementioned table, no IMD issue is observed.

The protected bands required for the 2UL bands CA configuration can refer to table 6.49.2.1-2 by replacing n20 with n92 since n20 and n92 have the exact same UL frequency.

6.61.2.2 REFSENS requirements

There is no specific MSD requirement.

6.62 CA_n41-n78

6.62.1 Common for 1 band UL and 2 bands UL CA

6.62.1.1 Operating bands for CA

Table 6.62.1.1-1: CA band combination CA_n41A-n78A

NR CA Band Combination	NR Band	Uplink (UL) band				Downlink (DL) band				Duplex mode				
		BS receive / UE transmit				BS transmit / UE receive								
		$F_{UL_low} - F_{UL_high}$				$F_{DL_low} - F_{DL_high}$								
CA_n41-n78	n41	2496 MHz		–		2690 MHz		2496 MHz		–		2690 MHz		TDD
	n78	3300 MHz		–		3800 MHz		3300 MHz		–		3800 MHz		TDD

6.62.1.2 Channel bandwidths per operating band for CA

Table 6.62.1.2-1: Supported bandwidths per CA band combination CA_n41A-n78A

CA operating / channel bandwidth [MHz]																	
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	25	30	40	50	60	70	80	90	100	Bandwidth combination set
CA_n41A-n78A	CA_n41A-n78A	n41	15		Yes	Yes	Yes			Yes	Yes						0
			30		Yes	Yes	Yes			Yes	Yes	Yes		Yes		Yes	
			60		Yes	Yes	Yes			Yes	Yes	Yes		Yes		Yes	
		n78	15		Yes	Yes	Yes			Yes	Yes						
			30		Yes	Yes	Yes			Yes	Yes	Yes		Yes	Yes	Yes	
			60		Yes	Yes	Yes			Yes	Yes	Yes		Yes	Yes	Yes	
	n41	15			Yes	Yes	Yes		Yes	Yes	Yes						1
		30			Yes	Yes	Yes		Yes	Yes	Yes		Yes	Yes	Yes		
		60			Yes	Yes	Yes		Yes	Yes	Yes		Yes	Yes	Yes		
		n78	15		Yes	Yes	Yes		Yes	Yes	Yes						
			30		Yes	Yes	Yes		Yes	Yes	Yes		Yes	Yes	Yes		
			60		Yes	Yes	Yes		Yes	Yes	Yes		Yes	Yes	Yes		

6.62.1.3 Co-existence studies

Table 6.62.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n41-n78.

Table 6.62.1.3-1: Impact of UL/DL Harmonic

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2nd Harmonic		3rd Harmonic		4th Harmonic	
					UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n41	2496	2690	2496	2690	4992	5380	7488	8070	9984	10760
n78	3300	3800	3300	3800	6600	7600	9900	11400	13200	15200

Based on above table, there is no harmonic issue for this band combination.

Table 6.62.1.3-2: Impact of UL/DL Harmonic mixing

					2nd Harmonic		3rd Harmonic		m th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n41	2496	2690	2496	2690	4992	5380	7488	8070		
n78	3300	3800	3300	3800	6600	7600	9900	11400		

The harmonics mixing exception for the band combination of n41 and n78 has been specified in the spec since Rel-15.

6.62.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n41A-n78A, the $\Delta T_{IB,c}$ and ΔR_{IB} are given in the tables below.

Table 6.62.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n41-n78	n41	0.3
	n78	0.8

Table 6.62.1.4-2: ΔR_{IB}

Inter-band CA Configuration	NR Band	ΔR_{IB} [dB]
CA_n41-n78	n41	0
	n78	0.5

6.62.1.5 REFSENs requirements

The specific MSD exception requirement has been specified in the spec since Rel-15, but it seems cross band isolation and harmonic mixing issue haven't been completed Based on the MSD for DC_41_n78, the exception can be specified as below.

Table 6.62.1.5-1: Reference sensitivity exceptions due to harmonic mixing for CA in NR FR1

		NR Band / Channel bandwidth of the affected DL band												
UL band	DL band	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	30 MHz (dB)	40 MHz (dB)	50 MHz (dB)	60 MHz (dB)	70 MHz (dB)	80 MHz (dB)	90 MHz (dB)	100 MHz (dB)
n78	n41 ²		10.4	10.4	10.4			8.2	7.6	7.3		6.6	6.4	6.3

NOTE 1: The requirements should be verified for UL NR-ARFCN of the aggressor (lower) band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.15 \rfloor 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{HB} carrier frequency in the victim (higher) band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the lower band.

NOTE 2: The requirements should be verified for UL NR-ARFCN of the aggressor (high) band (superscript HB) such that $f_{UL}^{LB} = \lfloor 15 * f_{DL}^{HB} \rfloor 0.1$ in MHz and $F_{UL_low}^{HB} + BW_{Channel}^{HB} / 2 \leq f_{UL}^{HB} \leq F_{UL_high}^{HB} - BW_{Channel}^{HB} / 2$ with f_{DL}^{LB} carrier frequency in the victim (lower) band in MHz and $BW_{Channel}^{HB}$ the channel bandwidth configured in the higher band.

NOTE 3: These requirements apply when there is at least one individual RE within the downlink transmission bandwidth of the victim (lower) band for which the 3rd harmonic is within the uplink transmission bandwidth or the uplink adjacent channel's transmission bandwidth of an aggressor (higher) band.

NOTE 4: The requirements should be verified for UL NR-ARFCN of the aggressor (higher) band (superscript HB) such that $f_{DL}^{LB} = \lfloor f_{UL}^{HB} / 0.3 \rfloor 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{LB} the carrier frequency in the victim (lower) band and $BW_{Channel}^{HB}$ the channel bandwidth configured in the higher band.

Table 6.62.1.5-2: Uplink configuration for reference sensitivity exceptions due to receiver harmonic mixing for CA in NR FR1

		NR Band / SCS / Channel bandwidth of the affected DL band													
UL band	DL band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	70 MHz	80 MHz	90 MHz	100 MHz
n78	n41	30		50	50	50		50	50	50	50		50	50	50

NOTE 1: The UL configuration applies regardless of the channel bandwidth of the UL band unless the UL resource blocks exceed that specified in Table 7.3.2-3 for the uplink bandwidth in which case the allocation according to Table 7.3.2-3 applies.

Table 6.62.1.5-3: MSD for the CA configuration for asynchronous operation and cross band isolation for CA

		NR Band / Channel bandwidth of the affected DL band													
NR CA Configuration	UL band	DL band	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	30 MHz (dB)	40 MHz (dB)	50 MHz (dB)	60 MHz (dB)	70 MHz (dB)	80 MHz (dB)	90 MHz (dB)	100 MHz (dB)
CA_n41A-n78A	n41	n78		8.3	8.3	8.3	7.3	6.5	6.3	5.3	4.5	4.3	4.0	3.9	3.8
	n78	n41 ¹		4.5	4.5	4.5		4.5	4.5	4.5	4.5		4.5	4.5	4.5

NOTE 1: Applicable only when harmonic mixing MSD for this combination is not applied.
NOTE 2: Void

Table 6.62.1.5-4: Uplink configuration for reference sensitivity exceptions due to cross band isolation for CA

UL band	DL ban d	SCS of UL band (kHz)	NR Band / SCS / Channel bandwidth of the affected DL band												
			5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	70 MHz	80 MHz	90 MHz	100 MHz
n41	n78	15		100	100	100	100	100	100	100	100	100	100	100	100
n78	n41	30		270	270	270		270	270	270	270		270	270	270
NOTE 1: The UL configuration applies regardless of the channel bandwidth of the UL band unless the UL resource blocks exceed that specified in Table 7.3.2-3 for the uplink bandwidth in which case the allocation according to Table 7.3.2-3 applies.															
NOTE 2: Refers to 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 in Table 5.3.2-1.															

6.62.2 Specific for 2 bands UL CA

6.62.2.1 UE co-existence studies

Table 6.62.2.1-1 gives IMD interference analysis for CA_n41-n78 with 2 ULs.

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	2496	2690	3300	3800
2 nd harmonics frequency limits (MHz)	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2 nd harmonics frequency limits (MHz)	4992	5380	6600	7600
3 rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3 rd harmonics frequency limits (MHz)	7488	8070	9900	11400
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	9984	10760	13200	15200
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	12480	13450	16500	19000
2 nd order IMD products	fy_low - fx_high	fy_high - fx_low	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	610	1304	5796	6490
Two-tone 3 rd order IMD products	2*fx_low - fy_high	2*fx_high - fy_low	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	1192	2080	3910	5104
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high

IMD frequency limits (MHz)	8292	9180	9096	10290
Two-tone 4 th order IMD products	$ 3*fx_low - 1*fy_high $	$ 3*fx_high - 1*fy_low $	$ 3*fy_low - 1*fx_high $	$ 3*fy_high - 1*fx_low $
IMD frequency limits (MHz)	3688	4770	7210	8904
Two-tone 4 th order IMD products	$ 3*fx_low + 1*fy_low $	$ 3*fx_high + 1*fy_high $	$ 3*fy_low + 1*fx_low $	$ 3*fy_high + 1*fx_high $
IMD frequency limits (MHz)	10788	11870	12396	14090
Two-tone 4 th order IMD products	$ 2*fx_low - 2*fy_high $	$ 2*fx_high - 2*fy_low $	$ 2*fx_low + 2*fy_low $	$ 2*fx_high + 2*fy_high $
IMD frequency limits (MHz)	2608	1220	11592	12980
Two-tone 5 th order IMD products	$ fx_low - 4*fy_high $	$ fx_high - 4*fy_low $	$ fy_low - 4*fx_high $	$ fy_high - 4*fx_low $
IMD frequency limits (MHz)	12704	10510	7460	6184
Two-tone 5 th order IMD products	$ 2*fx_low - 3*fy_high $	$ 2*fx_high - 3*fy_low $	$ 2*fy_low - 3*fx_high $	$ 2*fy_high - 3*fx_low $
IMD frequency limits (MHz)	6408	4520	1470	112
Two-tone 5 th order IMD products	$ fx_low + 4*fy_low $	$ fx_high + 4*fy_high $	$ fy_low + 4*fx_low $	$ fy_high + 4*fx_high $
IMD frequency limits (MHz)	15696	17890	13284	14560
Two-tone 5 th order IMD products	$ 2*fx_low + 3*fy_low $	$ 2*fx_high + 3*fy_high $	$ 2*fy_low + 3*fx_low $	$ 2*fy_high + 3*fx_high $
IMD frequency limits (MHz)	14892	16780	14088	15670

For TDD combination CA_n41-n78, no IMD interference will fall into Rx.

Table 6.62.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.62.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA Configuration	Spurious emission					
	Protected Band	Frequency range (Mhz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n41-n78	E-UTRA Band 1, 3, 5, 8, 26, 28, 34, 39, 65	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 11, 18, 19, 21	F_{DL_low}	-	F_{DL_high}	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3
NOTE 3: Applicable when co-existence with PHS system operating in 1884.5 -1915.7 MHz						
NOTE 10: This requirement applies when the NR carrier is confined within 2545 - 2575 MHz or 2595 – 2645vMHz and the channel bandwidth is 10 or 20 MHz.						

6.62.2.2 REFSENS requirements

There is no additional IMD exception requirements for two UL CA_n41A-n78A

6.63 n1-n40

6.63.1 Common for 1 band UL and 2 bands UL CA

6.63.1.1 Operating bands for CA

Table 6.63.1.1-1: CA band combination of band n1 and n40

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
	BS receive / UE transmit			BS transmit / UE receive				
	$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$				
n1	1920 MHz	–	1980 MHz	2110 MHz	–	2170 MHz	FDD	
n40	2300 MHz	–	2400 MHz	2300 MHz	–	2400 MHz	TDD	

6.63.1.2 Channel bandwidths per operating band for CA

Table 6.63.1.2-1: Supported bandwidths per CA band combination of band n1 and n40

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Bandwidth combination set
CA_n1A-n40A	CA_n1A-n40A	n1	15	Yes	Yes	Yes	Yes									100
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
		n40	15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes					
			30		Yes											
			60		Yes											

6.63.1.3 UE co-existence studies

Table 6.63.1.3-1 lists up to 7th harmonics for n1A-n40A. As can be seen there are no harmonic issues.

Table 6.63.1.3-1: Impact of UL/DL Harmonic

			2 nd Harmonic		3 rd Harmonic		4 th Harmonic		5 th Harmonic		6 th Harmonic		7 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n1	1920	1980	3840	3960	5760	5940	7680	7920	9600	9900	11520	11880	13440	13860
n40	2300	2400	4600	4800	6900	7200	9200	9600	11500	12000	13800	14400	16100	16800

Table 6.63.1.3-2 list harmonic mixing issue for the 2DL bands CA with 1 UL. As can be seen there are no harmonic mixing issues.

Table 6.63.1.3-2 Harmonic mixing for 2DLs/1UL

Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	2 nd Harmonic		3 rd Harmonic		4 th Harmonic	
					DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n1	1920	1980	2110	2170	4220	4340	6330	6510	8440	8680
n40	2300	2400	2300	2400	4600	4800	6900	7200	9200	9600

6.63.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n1-n40, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are derived from LTE combination CA_1-40 and are given in the tables below.

Table 6.63.1.4-1: $\Delta T_{IB,c}$

NR CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n1-n40	n1	0.5
	n40	0.5

Table 6.63.1.4-2: $\Delta R_{IB,c}$

NR CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n1-n40	n1	0
	n40	0

6.63.1.5 REFSENS requirements

As can be seen in the co-existence studies in 6.63.1.3 there are no harmonics issues.

6.63.2 Specific for 2 bands UL CA

6.63.2.1 UE co-existence studies

Table 6.63.2.1-1 lists Band n1 + Band n40 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.63.2.1-1: Band n1 and Band n40 UL IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	1920	1980	2300	2400
2nd harmonics frequency limits	$2*fy_{low}$	$2*fy_{high}$	$2*fx_{low}$	$2*fx_{high}$
2nd harmonics frequency limits (MHz)	3840	3960	4600	4800
3rd harmonics frequency limits	$3*fy_{low}$	$3*fy_{high}$	$3*fx_{low}$	$3*fx_{high}$
3rd harmonics frequency limits (MHz)	5760	5940	6900	7200
4th harmonics frequency limits	$4*fy_{low}$	$4*fy_{high}$	$4*fx_{low}$	$4*fx_{high}$
4th harmonics frequency limits (MHz)	7680	7920	9200	9600
5th harmonics frequency limits	$5*fy_{low}$	$5*fy_{high}$	$5*fx_{low}$	$5*fx_{high}$
5th harmonics frequency limits (MHz)	9600	9900	11500	12000
6th harmonics frequency limits	$6*fy_{low}$	$6*fy_{high}$	$6*fx_{low}$	$6*fx_{high}$
6th harmonics frequency limits (MHz)	11520	11880	13800	14400
7th harmonics frequency limits	$7*fy_{low}$	$7*fy_{high}$	$7*fx_{low}$	$7*fx_{high}$
7th harmonics frequency limits (MHz)	13440	13860	16100	16800
2nd order IMD products	$ fy_{high} - fx_{low} $	$ fy_{low} - fx_{high} $	$ fy_{low} + fx_{low} $	$ fy_{high} + fx_{high} $
IMD frequency limits (MHz)	480	320	4220	4380
3rd order IMD products	$ fy_{high} - 2*fx_{low} $	$ fy_{low} - 2*fx_{high} $	$ 2*fy_{low} - fx_{high} $	$ 2*fy_{high} - fx_{low} $
IMD frequency limits (MHz)	1440	1660	2620	2880
3rd order IMD products	$ 2*fx_{low} + fy_{low} $	$ 2*fx_{high} + fy_{high} $	$ 2*fy_{low} + fx_{low} $	$ 2*fy_{high} + fx_{high} $
IMD frequency limits (MHz)	6140	6360	6520	6780
Two-tone 4th order IMD products	$ 2*fx_{low} - 2*fy_{high} $	$ 2*fx_{high} - 2*fy_{low} $	$ 2*fx_{low} + 2*fy_{low} $	$ 2*fx_{high} + 2*fy_{high} $
IMD frequency limits (MHz)	960	640	8440	8760
Two-tone 4th order IMD products	$ 3*fx_{low} - 1*fy_{high} $	$ 3*fx_{high} - 1*fy_{low} $	$ 3*fy_{low} - 1*fx_{high} $	$ 3*fy_{high} - 1*fx_{low} $
IMD frequency limits (MHz)	3360	3640	4920	5280
Two-tone 4th order IMD products	$ 3*fx_{low} + 1*fy_{low} $	$ 3*fx_{high} + 1*fy_{high} $	$ 3*fy_{low} + 1*fx_{low} $	$ 3*fy_{high} + 1*fx_{high} $
IMD frequency limits (MHz)	8060	8340	8820	9180
Two-tone 5th order IMD products	$ fx_{low} - 4*fy_{high} $	$ fx_{high} - 4*fy_{low} $	$ fy_{low} - 4*fx_{high} $	$ fy_{high} - 4*fx_{low} $
IMD frequency limits (MHz)	7680	7220	5620	5280
Two-tone 5th order IMD products	$ fx_{low} + 4*fy_{low} $	$ fx_{high} + 4*fy_{high} $	$ fy_{low} + 4*fx_{low} $	$ fy_{high} + 4*fx_{high} $
IMD frequency limits (MHz)	11120	11580	9980	10320
Two-tone 5th order IMD products	$ 2*fx_{low} - 3*fy_{high} $	$ 2*fx_{high} - 3*fy_{low} $	$ 2*fy_{low} - 3*fx_{high} $	$ 2*fy_{high} - 3*fx_{low} $
IMD frequency limits (MHz)	3360	2940	1340	960
Two-tone 5th order IMD products	$ 2*fx_{low} + 3*fy_{low} $	$ 2*fx_{high} + 3*fy_{high} $	$ 2*fy_{low} + 3*fx_{low} $	$ 2*fy_{high} + 3*fx_{high} $
IMD frequency limits (MHz)	10740	11160	10360	10740

Based on Table 6.63.2.1-1 there are no IMD issues affecting own Rx frequencies.

Table 6.63.2.1-2 lists the protected bands required for the 2UL bands CA configuration as to be used in Table 6.5A.3.2.3-1 of TS 38.101-1, and with same bands as for DC_1_n40 in TS 38.101-3.

Table 6.63.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission						
	Protected band		Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n1-n40	E-UTRA Band 1, 5, 7, 8, 11, 18, 19, 20, 21, 22, 26, 27, 28, 31, 32, 38, 41, 42, 43, 44, 45, 50, 51, 52, 65, 67, 68, 69, 72, 73, 74, 75, 76	F_{DL_low}	-	F_{DL_high}	-50	1	
	Band 3, 34	F_{DL_low}	-	F_{DL_high}	-50	1	4
	Frequency range	1880		1895	-40	1	4, 14
	Frequency range	1895		1915	-15.5	5	4, 7, 14
	Frequency range	1915		1920	+1.6	5	4, 7, 14
NOTE 4: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.							
NOTE 7: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.							
NOTE 14: This requirement is applicable in the case of a 10 MHz NR carrier confined within 703 MHz and 733 MHz, otherwise the requirement of -25 dBm with a measurement bandwidth of 8 MHz applies.							

6.63.2.2 REFSENS requirements

There is a need to define MSD for CA_n1-n40. Same MSD values as for DC_1_n40.

Table 6.63.2.2-1: MSD for the CA configuration for asynchronous operation and cross band isolation for CA

NR Band / Channel bandwidth of the affected DL band														
NR CA Configuration	UL band	DL band	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	30 MHz (dB)	40 MHz (dB)	50 MHz (dB)	60 MHz (dB)	80 MHz (dB)	90 MHz (dB)	100 MHz (dB)
CA_n1-n40	n40	n1	8.3	8.3	8.3	8.3								
CA_n1-n40	n1	n40	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6		

Table 6.63.2.2-2: Uplink configuration for reference sensitivity exceptions due to cross band isolation for CA

NR Band / SCS / Channel bandwidth of the affected DL band														
UL band	DL band	SCS of UL band (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n40	n1	30	25	50	75	100								
n1	n40	15	25	50	75	100	100	100	100	100	100	100		

6.64 n28-n40

6.64.1 Common for 1 band UL and 2 bands UL CA

6.64.1.1 Operating bands for CA

Table 6.64.1.1-1: CA band combination of band n28 and n40

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
	BS receive / UE transmit			BS transmit / UE receive				
	$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$				
n28	703 MHz	–	748 MHz	758 MHz	–	803 MHz	FDD	
n40	2300 MHz	–	2400 MHz	2300 MHz	–	2400 MHz	TDD	

6.64.1.2 Channel bandwidths per operating band for CA

Table 6.64.1.2-1: Supported bandwidths per CA band combination of band n28 and n40

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Bandwidth combination set
CA_n28 A-n40A	CA_n28A -n40A	n28	15	Yes	Yes	Yes	Yes									100
			30		Yes	Yes	Yes									
			60		Yes	Yes	Yes									
	n40	n40	15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes					
			30		Yes											
			60		Yes											

6.64.1.3 UE co-existence studies

Table 6.64.1.3-1 lists up to 7th harmonics for n28A-n40A.

Table 6.64.1.3-1: Harmonic Interference for 2DLs/1UL

Band							2 nd Harmonic		3 rd Harmonic		4 th Harmonic	
	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n28	703	748	758	803	1406	1496	2109	2244	2812	2992		
n40	2300	2400	2300	2400	4600	4800	6900	7200	9200	9600		

Table 6.64.1.3-2 list harmonic mixing issue for the 2DL bands CA with 1 UL. It can be seen that 3rd harmonic DL mixing from band n28 DL will affect band n40 UL.

Table 6.64.1.3-2 Harmonic mixing for 2DLs/1UL

Band							2 nd Harmonic		3 rd Harmonic		4 th Harmonic	
	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n28	703	748	758	803	1516	1606	2274	2409	3032	3212		
n40	2300	2400	2300	2400	4600	4800	6900	7200	9200	9600		

6.64.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n28-n40, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are derived from CA_28-40 and are given in the tables below.

Table 6.64.1.4-1: $\Delta T_{IB,c}$

NR CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n28-n40	n28	0.3
	n40	0.3

Table 6.64.1.4-2: $\Delta R_{IB,c}$

NR CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n28-n40	n28	0
	n40	0

6.64.1.5 REFSENS requirements

Additional REFSENS requirements are needed to be defined in tables below in TS 38.101-1 due to 3rd harmonic DL mixing from band n28 UL affecting band n40 DL. Values are reused from CA_28-40.

Table 6.64.1.5-1: Reference sensitivity exceptions due to harmonic mixing for CA in NR FR1

NR Band / Channel bandwidth of the affected DL band												
UL band	DL band	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	40 MHz (dB)	50 MHz (dB)	60 MHz (dB)	80 MHz (dB)	90 MHz (dB)	100 MHz (dB)
n40	n28 ⁴	37.8	34.8	33	30.3							

NOTE 4: The requirements should be verified for UL NR-ARFCN of the aggressor (higher) band (superscript HB) such that $f_{DL}^{LB} = \lfloor f_{UL}^{HB} / 0.3 \rfloor 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{LB} the carrier frequency in the victim (lower) band and $BW_{Channel}^{HB}$ the channel bandwidth configured in the higher band.

Table 6.64.1.5-2: Uplink configuration for reference sensitivity exceptions due to receiver harmonic mixing for CA in NR FR1

NR Band / SCS / Channel bandwidth of the affected DL band													
UL band	DL band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n40	n28	15	25	50	75	100							

6.64.2 Specific for 2 bands UL CA

6.64.2.1 UE co-existence studies

Table 6.64.2.1-1 lists Band n28 + Band n40 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.64.2.1-1: Band n28 and Band n40 UL IMD products

UE UL carriers	fx_{low}	fx_{high}	fy_{low}	fy_{high}
2nd order IMD products	$ fy_{high} - fx_{low} $	$ fy_{low} - fx_{high} $	$ fy_{low} + fx_{low} $	$ fy_{high} + fx_{high} $
IMD frequency limits (MHz)	1697	1552	3003	3148
3rd order IMD products	$ fy_{high} - 2*fx_{low} $	$ fy_{low} - 2*fx_{high} $	$ 2*fy_{low} - fx_{high} $	$ 2*fy_{high} - fx_{low} $
IMD frequency limits (MHz)	994	804	3852	4097
3rd order IMD products	$ 2*fx_{low} + fy_{low} $	$ 2*fx_{high} + fy_{high} $	$ 2*fy_{low} + fx_{low} $	$ 2*fy_{high} + fx_{high} $
IMD frequency limits (MHz)	3706	3896	5303	5548
Two-tone 4th order IMD products	$ 2*fx_{low} - 2*fy_{high} $	$ 2*fx_{high} - 2*fy_{low} $	$ 2*fx_{low} + 2*fy_{low} $	$ 2*fx_{high} + 2*fy_{high} $
IMD frequency limits (MHz)	3394	3104	6006	6296
Two-tone 4th order IMD products	$ 3*fx_{low} - 1*fy_{high} $	$ 3*fx_{high} - 1*fy_{low} $	$ 3*fy_{low} - 1*fx_{high} $	$ 3*fy_{high} - 1*fx_{low} $
IMD frequency limits (MHz)	291	56	6152	6497
Two-tone 4th order IMD products	$ 3*fx_{low} + 1*fy_{low} $	$ 3*fx_{high} + 1*fy_{high} $	$ 3*fy_{low} + 1*fx_{low} $	$ 3*fy_{high} + 1*fx_{high} $
IMD frequency limits (MHz)	4409	4644	7603	7948
Two-tone 5th order IMD products	$ fx_{low} - 4*fy_{high} $	$ fx_{high} - 4*fy_{low} $	$ fy_{low} - 4*fx_{high} $	$ fy_{high} - 4*fx_{low} $
IMD frequency limits (MHz)	8897	8452	692	412
Two-tone 5th order IMD products	$ fx_{low} + 4*fy_{low} $	$ fx_{high} + 4*fy_{high} $	$ fy_{low} + 4*fx_{low} $	$ fy_{high} + 4*fx_{high} $
IMD frequency limits (MHz)	9903	10348	5112	5392
Two-tone 5th order IMD products	$ 2*fx_{low} - 3*fy_{high} $	$ 2*fx_{high} - 3*fy_{low} $	$ 2*fy_{low} - 3*fx_{high} $	$ 2*fy_{high} - 3*fx_{low} $
IMD frequency limits (MHz)	5794	5404	2356	2691
Two-tone 5th order IMD products	$ 2*fx_{low} + 3*fy_{low} $	$ 2*fx_{high} + 3*fy_{high} $	$ 2*fy_{low} + 3*fx_{low} $	$ 2*fy_{high} + 3*fx_{high} $
IMD frequency limits (MHz)	8306	8696	6709	7044

Based on Table 6.64.2.1-1 there are no IMD issues affecting own Rx frequencies.

Table 6.64.2.1-2 lists the protected bands required for the 2UL bands CA configuration as to be used in Table 6.5A.3.2.3-1 of TS 38.101-1, and with same bands as for DC_8_n40 in TS 38.101-3.

Table 6.64.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n28-n40	E-UTRA Band 3, 5, 7, 8, 20, 26, 27, 31, 34, 38, 41, 72	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 22, 32, 42, 43, 50, 51, 52, 65, 73, 74, 75, 76 NR band n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1
NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2 \text{ MHz} + N \times L_{CRB} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.						2

6.64.2.2 REFSENS requirements

There are no additional REFSENS requirements needed for 2 bands UL.

6.65 n46-n48

6.65.1 Common for 1 band UL and 2 bands UL CA

6.65.1.1 Operating bands for CA

Table 6.65.1.1-1: CA band combination of band n46 and n48

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode		
	BS receive / UE transmit		BS transmit / UE receive				
	$F_{UL_low} - F_{UL_high}$		$F_{DL_low} - F_{DL_high}$				
n46	5150 MHz	–	5925 MHz	5150 MHz	–	5925 MHz	TDD
n48	3550 MHz	–	3700 MHz	3550 MHz	–	3700 MHz	

6.65.1.2 Channel bandwidths per operating band for CA

Table 6.65.1.2-1: Supported bandwidths per CA band combination of band n46 and n48

NR CA configuration	Uplink Configurations	NR Band	Channel bandwidths for carrier [MHz]	Maximum Aggregated bandwidth (MHz)	Bandwidth combination set			
CA_n46A-n48A	CA_n46A-n48A	n46	20				40	0
		n48	20					

CA_n46B-n48A	CA_n46A-n48A	n46	20,40,60	20,40			120	0
		n48	20					
CA_n46C-n48A	CA_n46A-n48A	n46	60,80	60,80			180	0
		n48	20					
CA_n46D-n48A	CA_n46A-n48A	n46	60,80	80	80		260	0
		n48	20					
CA_n48A-n46E	CA_n46A-n48A	n46	80	80	80	80	340	0
		n48	20					

6.65.1.3 UE co-existence studies

Table 6.65.1.3-1 lists up to 7th harmonics for n46A-n48A.

Table 6.65.1.3-1: Impact of UL/DL Harmonic

Band	2 nd Harmonic		3 rd Harmonic		4 th Harmonic		5 th Harmonic		6 th Harmonic		7 th Harmonic			
	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge		
n46	5150	5925	10300	11850	15450	17775	20600	23700	25750	29625	30900	35550	36050	41475
n48	3550	3700	7100	7400	10650	11100	14200	14800	17750	18500	21300	22200	24850	25900

6.65.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n46-n48, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are derived from LTE combination CA_46-48 and are given in the tables below.

Table 6.65.1.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
CA_n46-n48	n46	0
	n48	0.8

Table 6.65.1.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
CA_n46-n48	n46	0
	n48	0.5

6.65.1.5 REFSENS requirements

As can be seen in the co-existence studies in 6.65.1.3 there are no harmonics issues.

6.65.2 Specific for 2 bands UL CA

6.65.2.1 UE co-existence studies

Table 6.65.2.1-1 lists Band n46 + Band n48 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.65.2.1-1: Band n46 and Band n48 UL IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	5150	5925	3550	3700
2nd harmonics frequency limits	2* fy_low	2* fy_high	2*fx_low	2*fx_high
2nd harmonics frequency limits (MHz)	10300	11850	7100	7400
3rd harmonics frequency limits	3* fy_low	3* fy_high	3*fx_low	3*fx_high
3rd harmonics frequency limits (MHz)	15450	17775	10650	11100
4th harmonics frequency limits	4* fy_low	4* fy_high	4*fx_low	4*fx_high
4th harmonics frequency limits (MHz)	20600	23700	14200	14800
5th harmonics frequency limits	5* fy_low	5* fy_high	5*fx_low	5*fx_high
5th harmonics frequency limits (MHz)	25750	29625	17750	18500
6th harmonics frequency limits	6* fy_low	6* fy_high	6*fx_low	6*fx_high
6th harmonics frequency limits (MHz)	30900	35550	21300	22200
7th harmonics frequency limits	7* fy_low	7* fy_high	7*fx_low	7*fx_high
7th harmonics frequency limits (MHz)	36050	41475	24850	25900
2nd order IMD products	fy_high - fx_low	fy_low - fx_high	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	1450	2375	8700	9625
3rd order IMD products	fy_high - 2*fx_low	fy_low - 2*fx_high	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	6600	8300	1175	2250
3rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	13850	15550	12250	13325
Two-tone 4th order IMD products	2*fx_low - 2* fy_high	2*fx_high - 2*fy_low	2*fx_low + 2* fy_low	2*fx_high + 2* fy_high
IMD frequency limits (MHz)	2900	4750	17400	19250
Two-tone 4th order IMD products	3*fx_low - 1* fy_high	3*fx_high - 1*fy_low	3*fy_low - 1*fx_high	3*fy_high - 1*fx_low
IMD frequency limits (MHz)	9525	14225	4725	5950
Two-tone 4th order IMD products	3*fx_low + 1* fy_low	3*fx_high + 1* fy_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high
IMD frequency limits (MHz)	19000	21475	15800	17025
Two-tone 5th order IMD products	fx_low - 4*fy_high	fx_high - 4*fy_low	fy_low - 4*fx_high	fy_high - 4*fx_low
IMD frequency limits (MHz)	9650	10500	20150	16900
Two-tone 5th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
IMD frequency limits (MHz)	19350	20725	24150	27400
Two-tone 5th order IMD products	2*fx_low - 3*fy_high	2*fx_high - 3*fy_low	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)	800	1200	10675	8050
Two-tone 5th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	20950	22950	22550	25175

Based on Table 6.65.2.1-1 there are no IMD issues affecting own Rx frequencies of either band n46 or band n48.

Table 6.65.2.1-2 lists the protected bands required for the 2UL bands CA configuration as to be used in Table 6.5A.3.2.3-1 of TS 38.101-1

Table 6.65.2.1-2: Protected bands for the 2UL bands CA configuration

E-UTRA and NR CA Configuration	Spurious emission						
	Protected band		Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n48_n46	E-UTRA Band 2, 4, 5, 12, 13, 14, 17, 24, 25, 26, 29, 30, 41, 50, 51, 66, 70, 71, 74, 85	F_{DL_low}	-	F_{DL_high}	-50	1	

6.65.2.2 Reference sensitivity exceptions due to Cross band isolation for NR-CA in NR FR1

Table 6.65.2.2-1: Reference sensitivity exceptions (MSD) due to cross band isolation for NR-CA in NR FR1

	NR Band / Channel bandwidth of the affected DL band / MSD													
UL band	DL band	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	30 MHz (dB)	40 MHz (dB)	50 MHz (dB)	60 MHz (dB)	80 MHz (dB)	90 MHz (dB)	100 MHz (dB)	
n48	n46	-	-	-	7	-	-	5.7	-	5.1	4.7	-	-	
n46	n48	13.3	10.4	8.8	7.8	-	-	7.8	7	6.5	5.7	5.4	5.1	

Table 6.65.2.2-2: Uplink configuration for reference sensitivity exceptions due to cross band isolation for NR-CA

NR Band / SCS / Channel bandwidth of the affected DL band														
UL band	DL band	SCS of UL band (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
n48	n46	15				216			216		216	216		
n46	n48	30	216	216	216	216			216	216	216	216	216	216

Assumptions:

Parameter	Value	Unit
Antenna isolation	10	dB
filter minimum rejection from B48/n48 to n46 and vice versa.	33	dB
Front-end loss	4	dB

Thermal noise at B48/n48 RX ANT port	-166	dBm/Hz
Thermal noise at n46 RX ANT port	-163	dBm/Hz
Transceiver effective phase noise	-150	dBc/Hz
PA output noise at receiver freq range	-130	dBm/Hz
SNR requirement for QPSK	-1	dB

6.66 n25-n46

6.66.1 Common for 1 band UL and 2 bands UL CA

6.66.1.1 Operating bands for CA

Table 6.66.1.1-1: CA band combination of band n25 and n46

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode
	BS receive / UE transmit		BS transmit / UE receive				
	$F_{UL_low} - F_{UL_high}$	$F_{DL_low} - F_{DL_high}$					
n25	1850 MHz	–	1915 MHz	1930 MHz	–	1995 MHz	FDD
n46	5150 MHz	–	5925 MHz	5150 MHz	–	5925 MHz	TDD

6.66.1.2 Channel bandwidths per operating band for CA

Table 6.66.1.2-1: Supported bandwidths per CA band combination of band n25 and n46

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Bandwidth combination set
CA_n25 A-n46A	n25	15	Yes	Yes	Yes	Yes										0
		30		Yes	Yes	Yes										
		60		Yes	Yes	Yes										
	n46	15				Yes				Yes						
		30				Yes				Yes			Yes	Yes		
		60				Yes				Yes			Yes	Yes		

6.66.1.3 UE co-existence studies

Table 6.66.1.3-1 lists up to 7th harmonics for n25A-n46A.

Table 6.66.1.3-1: Impact of UL/DL Harmonic

	2 nd Harmonic		3 rd Harmonic		4 th Harmonic		5 th Harmonic		6 th Harmonic		7 th Harmonic			
Band	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge		
n25	1850	1915	3700	3830	5550	5745	7400	7660	9250	9575	11100	11490	12950	13405
n46	5150	5925	10300	11850	15450	17775	20600	23700	25750	29625	30900	35550	36050	41475

6.66.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n25-n46, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are derived from LTE combination CA_25-46 and are given in the tables below.

Table 6.66.1.4-1: $\Delta T_{IB,c}$

NR CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n25-n46	n25	0
	n46	0

Table 6.66.1.4-2: $\Delta R_{IB,c}$

NR CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n25-n46	n25	0
	n46	0

6.66.1.5 REFSENS requirements

As can be seen in the co-existence studies in 6.66.1.3 there are 3rd harmonics issues from n25 UL into the n46 DL.

MSD for CA_n25-n46 is proposed to be defined like in table below, where Note 1 in Table 6.66.1.5-1 is derived from Note 5 in TS36.101 Table 7.3.1A-0eA.

The Table 6.66.1.5-2 is derived from TS36.101 Table 7.3.1A-0eC.

Table 6.66.1.5-1: Reference sensitivity QPSK PREFSENS (CA with n46)

E-UTRA or NR Band / Channel bandwidth of the affected DL band / MSD												
UL band	DL band	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	40 MHz (dB)	50 MHz (dB)	60 MHz (dB)	80 MHz (dB)	90 MHz (dB)	100 MHz (dB)
n25	n46				N/A		N/A		N/A	N/A		
n46	n25	26.5	26.5	26.5	26.5							
NOTE 1: These requirements do not apply when there is at least one individual RE within the downlink (victim) transmission bandwidth which falls into the reference sensitivity exclusion region as specified in Table 6.66.1.5-2.												

Table 6.66.1.5-2: n46 Reference sensitivity measurement exclusion region in MHz

Licensed Component Carriers / E-UTRA Band / Harmonic order / Channel BW in UL						
Band	Harmonic order	5MHz	10MHz	15MHz	20MHz	40MHz
n25	3	+/- 15	+/- 23	+/- 35	+/- 45	+/- 90
NOTE 1: Even though UL harmonic does not fall directly into n46 the exclusion region still applies.						
NOTE 2: The center of the exclusion region is obtained by multiplying the uplink channel center frequency by the harmonic order.						

6.67 n46-n66

6.67.1 Common for 1 band UL and 2 bands UL CA

6.67.1.1 Operating bands for CA

Table 6.67.1.1-1: CA band combination of band n46 and n66

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
	BS receive / UE transmit			BS transmit / UE receive				
	$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$				
n66	1710 MHz	–	1780 MHz	2110 MHz	–	2200 MHz	FDD	
n46	5150 MHz	–	5925 MHz	5150 MHz	–	5925 MHz	TDD	

6.67.1.2 Channel bandwidths per operating band for CA

Table 6.67.1.2-1: Supported bandwidths per CA band combination of band n46 and n66

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Bandwidth combination set
CA_n46 A-n66A	n46	15					Yes			Yes						0
		30					Yes			Yes		Yes	Yes			
		60					Yes			Yes		Yes	Yes			
		15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes						
	n66	30		Yes	Yes	Yes	Yes	Yes	Yes	Yes						
		60		Yes	Yes	Yes	Yes	Yes	Yes	Yes						

6.67.1.3 UE co-existence studies

Table 6.67.1.3-1 lists up to 7th harmonics for n46A-n66A.

Table 6.67.1.3-1: Impact of UL/DL Harmonic

			2 nd Harmonic		3 rd Harmonic		4 th Harmonic		5 th Harmonic		6 th Harmonic		7 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n46	5150	5925	10300	11850	15450	17775	20600	23700	25750	29625	30900	35550	36050	41475
n66	1710	1780	3420	3560	5130	5340	6840	7120	8550	8900	10260	10680	11970	12460

6.67.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n46-n66, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are derived from LTE combination CA_46-66 and are given in the tables below.

Table 6.67.1.4-1: $\Delta T_{IB,c}$

NR CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n46-n66	n46	0
	n66	0

Table 6.67.1.4-2: $\Delta R_{IB,c}$

NR CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n46-n66	n46	0
	n66	0

6.67.1.5 REFSENS requirements

As can be seen in the co-existence studies in 6.67.1.3 there are 3rd harmonics issues from n66 UL into the n46 DL

MSD for CA_n46-n66 is proposed to be defined like in table below, where Note 1 in Table 6.67.1.5-1 is derived from Note 5 in TS36.101 Table 7.3.1A-0eA.

The Table 6.67.1.5-2 is derived from TS36.101 Table 7.3.1A-0eC.

Table 6.67.1.5-1: Reference sensitivity QPSK PREFSENS (CA with n46)

E-UTRA or NR Band / Channel bandwidth of the affected DL band / MSD												
UL band	DL band	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	40 MHz (dB)	50 MHz (dB)	60 MHz (dB)	80 MHz (dB)	90 MHz (dB)	100 MHz (dB)
n66	n46				N/A		N/A		N/A	N/A		

NOTE 1: These requirements do not apply when there is at least one individual RE within the downlink (victim) transmission bandwidth which falls into the reference sensitivity exclusion region as specified in Table 6.67.1.5-2.

Table 6.67.1.5-2: n46 Reference sensitivity measurement exclusion region in MHz

Licensed Component Carriers / E-UTRA Band / Harmonic order / Channel BW in UL						
Band	Harmonic order	5MHz	10MHz	15MHz	20MHz	40MHz
n66	3	+/- 15	+/- 23	+/- 35	+/- 45	+/- 90

NOTE 1: Even though UL harmonic does not fall directly into n46 the exclusion region still applies.
NOTE 2: The center of the exclusion region is obtained by multiplying the uplink channel center frequency by the harmonic order.

6.68 CA_n2-n77

6.68.1 Common for 1 band UL and 2 bands UL CA

6.68.1.1 Operating bands for CA

Table 6.68.1.1-1: CA band combination of band n2+n77

NR CA Band	NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
		BS receive / UE transmit		BS transmit / UE receive			
		F_{UL_low} – F_{UL_high}	F_{DL_low} – F_{DL_high}	F_{DL_low} – F_{DL_high}	F_{UL_low} – F_{UL_high}		
CA_n2-n77	n2	1850 MHz – 1910 MHz	1930 MHz – 1990 MHz	1930 MHz – 1990 MHz	1850 MHz – 1910 MHz	FDD	
	n77	3300 MHz – 4200 MHz	TDD				

6.68.1.2 Channel bandwidths per operating band for CA

Table 6.68.1.2-1: Supported NR bandwidths per CA configuration of band n2+n77

		CA operating / channel bandwidth															
NR CA Configuration	UL CA Configuration	Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	70 MHz	80 MHz	90 MHz	100 MHz	BCS
CA_n2A-n77A	CA_n2A-n77A	n2	15	Yes	Yes	Yes	Yes										0
			30		Yes	Yes	Yes										
			60		Yes	Yes	Yes										
	n77	n77	15		Yes												
			30		Yes												
			60		Yes												

6.68.1.3 UE co-existence studies

Table 6.68.1.3-1 and Table 6.68.1.3-2 capture the UL 2nd, 3rd, 4th and 5th harmonics and harmonic mixing for CA_n2A-n77A.

Table 6.68.1.3-1: Band n2 and Band n77 UL harmonics products

					2nd Harmonic		3rd Harmonic		4 th Harmonic		5 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n2	1850	1910	1930	1990	3700	3820	5550	5730	7400	7640	9250	9550
n77	3300	4200	3300	4200	6600	8400	9900	12600	16800	16800	16500	21000

Table 6.68.1.3-2: Band n2 and Band n77 UL harmonic mixing products

					2nd Harmonic		3rd Harmonic		4 th Harmonic		5 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n2	1850	1910	1930	1990	3860	3980	5790	5970	7720	7960	9650	9550
n77	3300	4200	3300	4200	6600	8400	9900	12600	13200	16800	16500	21000

In analysis, it could be seen,

- The 2nd harmonic interference from band n2 UL may fall into band n77 DL frequency range.
- The 2nd harmonic mixing products from band n2 may fall into band n77 DL frequency range.

The MSD should be considered to mitigate the impact of the interference for this combination.

6.68.1.4 $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values

For CA_n2-n77, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are given in the tables below.

Table 6.68.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n2-n77	n2	0.6
	n77	0.8

Table 6.68.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n2-n77	n2	0.2
	n77	0.5

6.68.1.5 REFSENS requirements

MSD values for band n77 due to 2nd harmonic of band n2 in combo CA_n2A-n77A are captured in Table 6.68.1.5-1.

Table 6.68.1.5-1: MSD due to harmonic issue for CA_n2-n77

MSD due to harmonic exception for the DL band														
UL band	DL band	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	30 MHz (dB)	40 MHz (dB)	50 MHz (dB)	60 MHz (dB)	70 MHz (dB)	80 MHz (dB)	90 MHz (dB)	100 MHz (dB)
n2	n77 ^{1, 2}		23.9	22.1	20.9	19.8	19.0	17.9	16.8	16.0	15.5	14.8	14.3	13.8
	n77 ³		1.1	0.8	0.3	0.1	0	0	0	0	0	0	0	0

NOTE 1: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (lower) band for which the 2nd transmitter harmonic is within the downlink transmission bandwidth of a victim (higher) band and a range ΔF_{HD} above and below the edge of this downlink transmission bandwidth. The value ΔF_{HD} depends on the band combination: $\Delta F_{HD} = 10$ MHz for CA_n1-n77, CA_n2-n77, CA_n2-n78, CA_n3-n77, CA_n3-n78, CA_n2-n48, CA_n25-n78, CA_n48-n66, CA_n66-n78

NOTE 2: The requirements should be verified for UL EARFCN or NR ARFCN of the aggressor (lower) band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.2 \rfloor + 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with carrier frequency in the victim (higher) band in MHz and the channel bandwidth configured in the lower band.

NOTE 3: The requirements are only applicable to channel bandwidths no larger than 20 MHz and with a carrier frequency at $\pm(20 + BW_{Channel}^{HB} / 2)$ MHz offset from $2f_{UL}^{LB}$ in the victim (higher band) with $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$, where $BW_{Channel}^{HB}$ are the channel bandwidths configured in the aggressor (lower) and victim (higher) bands in MHz, respectively.

The uplink configuration for reference sensitivity exceptions due to UL harmonic interference for the combo CA_n2A-n77A are captured in Table 6.68.1.5-2.

Table 6.68.1.5-2 Uplink configuration due to UL harmonic interference

NR Band / Channel bandwidth of the affected DL band / UL RB allocation of the aggressor band														
UL band	DL band	5 MHz (L _{CRB})	10 MHz (L _{CRB})	15 MHz (L _{CRB})	20 MHz (L _{CRB})	25 MHz (L _{CRB})	30 MHz (L _{CRB})	40 MHz (L _{CRB})	50 MHz (L _{CRB})	60 MHz (L _{CRB})	70 MHz (L _{CRB})	80 MHz (L _{CRB})	90 MHz (L _{CRB})	100 MHz (L _{CRB})
n2	n77	25	36	50	50	50	50	50	50	50	50	50	50	50

Sensitivity degradation is allowed for the impact to the received harmonic mixing to the victim band n2 DL frequency range in the configuration of CA_n2A-n77A. Reference sensitivity exceptions are captured in Table 6.68.1.5-3.

Table 6.68.1.5-3: MSD due to receiver harmonic mixing for CA in NR FR1

NR Band / Channel bandwidth of the affected DL band / MSD														
UL band	DL band	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	40 MHz (dB)	50 MHz (dB)	60 MHz (dB)	70 MHz (dB)	80 MHz (dB)	90 MHz (dB)	100 MHz (dB)	
n77	n2	6.7	5.0	4.0	3.7									

The uplink configuration of the aggressor band are captured in Table 6.68.1.5-4.

Table 6.68.1.5-4: Uplink configuration due to receiver harmonic mixing for CA in NR FR1

NR Band / SCS / Channel bandwidth of the affected DL band / UL RB allocation of the aggressor band														
UL band	DL band	SCS of UL band (kHz)	5 MHz (LCRB)	10 MHz (LCRB)	15 MHz (LCRB)	20 MHz (LCRB)	25 MHz (LCRB)	40 MHz (LCRB)	50 MHz (LCRB)	60 MHz (LCRB)	70 MHz (LCRB)	80 MHz (LCRB)	90 MHz (LCRB)	100 MHz (LCRB)
n77	n2	15	25	50	75	100								

6.68.2 Specific for 2 bands UL CA

6.68.2.1 UE co-existence studies

Table 6.68.2.1-1 lists band n2+band n77 2UL CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.68.2.1-1: Band n2 and Band n77 2 UL bands IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	1850	1910	3300	4200
Two tone 2 nd order IMD products	fy_low – fx_high	fy_high – fx_low	fx_low + fy_low	fx_high + fy_high
IMD frequency limits (MHz)	1390	2350	5150	6110
Two-tone 3 rd order IMD products	2*fx_low – fy_high	2*fx_high – fy_low	2*fy_low – fx_high	2*fy_high – fx_low
IMD frequency limits (MHz)	500	520	4690	6550
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	7000	8020	8450	10310
Two-tone 4 th order IMD products	3*fx_low – fy_high	3*fx_high – fy_low	3*fy_low – fx_high	3*fy_high – fx_low
IMD frequency limits (MHz)	1350	2430	7990	10750
Two-tone 4 th order IMD products	3*fx_low + fy_low	3*fx_high + fy_high	3*fy_low + fx_low	3*fy_high + fx_high
IMD frequency limits (MHz)	8850	9930	11750	14510
Two-tone 4 th order IMD products	2*fx_low – 2*fy_high	2*fx_high – 2*fy_low	2*fx_low + 2*fy_low	2*fx_high + 2*fy_high
IMD frequency limits (MHz)	4700	2780	10300	12220
Two-tone 5 th order IMD products	fx_low – 4*fy_high	fx_high – 4*fy_low	fy_low – 4*fx_high	fy_high – 4*fx_low
IMD frequency limits (MHz)	14950	11290	4340	3200
Two-tone 5 th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
IMD frequency limits (MHz)	15050	18710	10700	11840
Two-tone 5 th order IMD products	2*fx_low – 3*fy_high	2*fx_high – 3*fy_low	2*fy_low – 3*fx_high	2*fy_high – 3*fx_low
IMD frequency limits (MHz)	8900	6080	870	2850
Two-tone 5 th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	13600	16420	12150	14130

- The 2nd and 4th order IMD products from band n2 UL, and 5th band n77 UL may fall into band their own DL frequency range
- The 5th order IMD of band n77 UL may fall into Rx frequency of band n2

The MSD should be considered to mitigate the impact of the interference for this combination.

Table 6.68.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.68.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA combination	Spurious emission							
	Protected Band		Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n2-n77	E-UTRA Band 4, 5, 12, 13, 14, 17, 26, 29, 30, 41, 65, 66, 70, 71		F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 2, 25		F_{DL_low}	-	F_{DL_high}	-50	1	2
NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2 nd , 3 rd , 4 th or 5 th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2 \text{ MHz} + N \times L_{CRB} \times RB_{size} \text{ kHz})$, where N is 2, 3, 4, 5 for the 2 nd , 3 rd , 4 th or 5 th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.								

6.68.2.2 REFSENs requirements

Table 6.68.2.2-1 lists the MSD required for the dual connectivity configuration due to IMD2.

Based on above coexistence study, two-tone 2nd and 4th order IMD products may fall into the own Rx of Band n2, and two-tone 5th order IMD products may fall into the Rx of Band n2. The MSD for IMD2 and IMD4 are,

Table 6.68.2.2-1: MSD due to IMD issue

Operating band/ Channel bandwidth / N_{RB} / Duplex mode								
CA Configuration	Operating band	UL F_c (MHz)	UL/DL BW (MHz)	UL L_{CRB}	DL F_c (MHz)	MSD (dB)	Duplex mode	IMD order
CA_n2A-n77A	n2	1855	5	25	1935	26	FDD	IMD2
	n77	3790	10	50	3790	28.7 ⁵		
	n2	1885	5	25	1965	N/A	TDD	N/A
	n77	3690	10	50	3690	8.0		
	n2	1885	5	25	1965	10.7 ⁵	FDD	IMD4
	n77	3790	10	50	3790	N/A		
NOTE 5: Applicable only if operation with 4 antenna ports is supported in the band with carrier aggregation configured.								

6.69 CA_n5-n77

6.69.1 Common for 1 band UL and 2 bands UL CA

6.69.1.1 Operating bands for CA

Table 6.69.1.1-1: CA band combination of band n5+n77

NR CA Band	NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode
		BS receive / UE transmit		BS transmit / UE receive				
		F_{UL_low} – F_{UL_high}	F_{DL_low} – F_{DL_high}					
CA_n5-n77	n5	824 MHz – 849 MHz	869 MHz – 894 MHz					FDD
	n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz					TDD

6.69.1.2 Channel bandwidths per operating band for CA

Table 6.69.1.2-1: Supported NR bandwidths per CA configuration of band n5+n77

CA operating / channel bandwidth																	
NR CA Configuration	UL CA Configuration	Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	70 MHz	80 MHz	90 MHz	100 MHz	BCS
CA_n5A-n77A	CA_n5A-n77A	n5	15	Yes	Yes	Yes	Yes										0
			30		Yes	Yes	Yes										

6.69.1.3 UE co-existence studies

Table 6.69.1.3-1 and Table 6.69.1.3-2 capture the UL 2nd, 3rd, 4th, 5th harmonics and harmonic mixing for CA_n5A-n77A.

Table 6.69.1.3-1: Band n5 and Band n77 UL harmonics products

					2nd Harmonic		3rd Harmonic		4th Harmonic		5th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n5	824	849	869	894	1648	1698	2472	2547	3296	3396	4120	4245
n77	3300	4200	3300	4200	6600	8400	9900	12600	13200	16800	16500	21000

Table 6.69.1.3-2: Band n5 and Band n77 Harmonic mixing products

					2nd Harmonic		3rd Harmonic		4th Harmonic		5th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n5	824	849	869	894	1738	1788	2607	2682	3476	3576	4345	4470
n77	3300	4200	3300	4200	6600	8400	9900	12600	13200	16800	16500	21000

In analysis, it could be seen,

- The 4th and 5th harmonic interferences from band n5 UL may fall into band n77 DL frequency range
 - The 4nd harmonic mixing products from band n5 may fall into band n77 DL frequency range

The MSD should be considered to mitigate the impact of the interference for this combination.

For US operation, the 4th and 5th harmonic and harmonic mixing products from band n5 to band n77 DL are out of the US C-band frequency range. Therefore, there is no MSD considering the US deployment range (3700-3980MHz) inside the n77 band.

6.69.1.4 ΔT_{IB} and ΔR_{IB} values

For the CA n5-n77, the $\Delta T_{JB,c}$ and $\Delta R_{JB,c}$ values are given in the tables below.

Table 6.69.1.4-1: $\Delta T_{IB,c}$

Inter-band DA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n5-n77	n5	0.6
	n77	0.8

Table 6.69.1.4-2: $\Delta R_{|B,C}$

Inter-band DC Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n5-n77	n5	0.2
	n77	0.5

6.69.1.5 REFSENS requirements

For US operation, the 4th and 5th harmonic and harmonic mixing products from band n5 to band n77 DL are out of the US C-band frequency range. Therefore, there is no MSD considering the US deployment range (3700-3980MHz) inside the n77 band.

MSD values for Band n77 due to harmonic of Band n5 for CA_n5A-n77A are captured in Table 6.69.1.5-1.

Table 6.69.1.5-1: MSD due to UL harmonic issue for CA_n5-n77

UL band	DL band	NR Band / Channel bandwidth of the affected DL band / MSD												
		5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	30 MHz (dB)	40 MHz (dB)	50 MHz (dB)	60 MHz (dB)	70 MHz (dB)	80 MHz (dB)	90 MHz (dB)	100 MHz (dB)
n5	n77 ^{4,5}		10.5	8.9	7.8	7.2	6.5	5.1	4.2	3.5	2.8	2.3	2.1	1.4
n5	n77 ^{6,7}		10.4	8.9	7.8	7.4	6.5	4.7	3.7	3	2.35	1.7	1.2	0,7
NOTE 4: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (lower) band for which the 4 th transmitter harmonic is within the downlink transmission bandwidth of a victim (higher) band. NOTE 5: The requirements should be verified for UL EARFCN of the aggressor (lower) band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.4 \rfloor 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with carrier frequency in the victim (higher) band in MHz and the channel bandwidth configured in the lower band. NOTE 6: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of a low band for which the 5th transmitter harmonic is within the downlink transmission bandwidth of a high band. NOTE 7: The requirements should be verified for UL NR-ARFCN of a low band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.5 \rfloor 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{HB} the carrier frequency of a high band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the low band.														

The uplink configuration for reference sensitivity exceptions due to UL harmonic interference for CA_n5A-n77A are captured in Table 6.69.1.5-2.

Table 6.69.1.5-2 Uplink configuration due to UL harmonic interference

UL band	DL band	NR Band / Channel bandwidth of the affected DL band / UL RB allocation of the aggressor band												
		5 MHz (LCRB)	10 MHz (LCRB)	15 MHz (LCRB)	20 MHz (LCRB)	25 MHz (LCRB)	30 MHz (LCRB)	40 MHz (LCRB)	50 MHz (LCRB)	60 MHz (LCRB)	70 MHz (LCRB)	80 MHz (LCRB)	90 MHz (LCRB)	100 MHz (LCRB)
n5	n77	-	16	25	25	25	25	25	25	25	25	25	25	25

Sensitivity degradation is allowed for the impact to the received harmonic mixing due to n5 UL to the victim band n77 DL frequency range in the configuration of CA_n5A-n77A. Reference sensitivity exceptions are captured in Table 6.69.1.5-3.

Table 6.69.1.5-3: MSD due to receiver harmonic mixing for CA in NR FR1

UL band	DL band	MSD due to harmonic exception for the DL band											
		5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	40 MHz	50 MHz	60 MHz	70 MHz	80 MHz	100 MHz	
		dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	
n77	n5	5.7	4.0	3.0	2.7								

The uplink configuration of the aggressor band n5 are captured in Table 6.69.1.5-4.

Table 6.69.1.5-4: Uplink configuration due to receiver harmonic mixing for CA in NR FR1

UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	40 MHz	50 MHz	60 MHz	70 MHz	80 MHz	100 MHz
n77	n5	25	25	20	20							

6.69.2 Specific for 2 bands UL CA

6.69.2.1 UE co-existence studies

Table 6.69.2.1-1 lists Band n5 + Band n77 2UL CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.69.2.1-1: Band n5 and Band n77 2 UL bands IMD products

UE UL carriers	fx_low	fx_high	fy_high	
Two tone 2 nd order IMD products	fy_low – fx_high	fy_high – fx_low	fx_low + fy_low	fx_high + fy_high
IMD frequency limits (MHz)	2451	3376	4124	5049
Two-tone 3 rd order IMD products	2*fx_low – fy_high	2*fx_high – fy_low	2*fy_low – fx_high	2*fy_high – fx_low
IMD frequency limits (MHz)	2552	1602	5751	7576
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	4948	5898	7424	9249
Two-tone 4 th order IMD products	3*fx_low – fy_high	3*fx_high – fy_low	3*fy_low – fx_high	3*fy_high – fx_low
IMD frequency limits (MHz)	1728	753	9051	11776
Two-tone 4 th order IMD products	3*fx_low + fy_low	3*fx_high + fy_high	3*fy_low + fx_low	3*fy_high + fx_high
IMD frequency limits (MHz)	5772	6747	10724	13449
Two-tone 4 th order IMD products	2*fx_low – 2*fy_high	2*fx_high – 2*fy_low	2*fx_low + 2*fy_low	2*fx_high + 2*fy_high
IMD frequency limits (MHz)	6752	4902	8248	10098
Two-tone 5 th order IMD products	fx_low – 4*fy_high	fx_high – 4*fy_low	fy_low – 4*fx_high	fy_high – 4*fx_low
IMD frequency limits (MHz)	15976	12351	96	904
Two-tone 5 th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
IMD frequency limits (MHz)	14024	17649	6596	7596
Two-tone 5 th order IMD products	2*fx_low – 3*fy_high	2*fx_high – 3*fy_low	2*fy_low – 3*fx_high	2*fy_high – 3*fx_low
IMD frequency limits (MHz)	10952	8202	4053	5928
Two-tone 5 th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	11548	14298	9072	10947

There are no IMD products fell in the US C-band frequency range (3700-3980MHz). The IMD issue discussed below is for the band n77, and out of the frequency range of US C-band.

Based on the Table 6.69.2.1-1, it could be seen,

- The 4th order IMD from band n5 UL may fall into own Rx band frequency range, and 2nd order IMD from Band n77 may fall into own Rx band frequency range.
- The 4th order IMD from band n5 may fall into band n77 DL frequency range,
- The 5th order IMD from band n77 may fall into band n5 DL frequency range

The MSD should be considered to mitigate the impact of the interference for this combination.

Table 6.69.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.69.2.1-2: Protected bands for the 2UL bands CA configuration

NR CA combination	Spurious emission					
	Protected Band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n5-n77	E-UTRA Band 2, 4, 12, 13, 14, 17, 25, 26, 28, 29, 30, 65, 66, 70, 71	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 41	F_{DL_low}	-	F_{DL_high}	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3
<p>NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2 \text{ MHz} + N \times L_{CRB} \times RB_{size} \text{ kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.</p> <p>NOTE 3: 15 kHz SCS is assumed when RB is mentioned in the note when channel bandwidth is less than or equal to 50 MHz, lowest SCS is assumed when channel bandwidth is larger than 50 MHz. The transmission bandwidth in terms of RB position and range is not limited to 15 kHz SCS and shall scale with SCS accordingly.</p>						

6.69.2.2 REFSENs requirements

Table 6.69.2.2-1 lists the MSD required for the dual connectivity configuration due to IMD4. And, the IMD produces are [outside of](#) the frequency range of US C-band.

Based on above coexistence study, two-tone 2nd order IMD products may fall into the own Rx Band of Band n77, and two-tone 4th order IMD products may fall into the own Rx Band of Band n5. The n77 is a TDD band hence there is no issue for the case IMD products fall into own RX band. The MSD requirements for both IMD4 and IMD5 from band 77 UL may fall into band n5 Rx are listed in Table 6.69.2.2-1 for the dual connectivity configuration.

Table 6.69.2.2-1: MSD due to IMD issue

NR or E-UTRA Band / Channel bandwidth / N _{RB} / MSD							
EN-DC Configuration	EUTRA or NR band	UL F _c (MHz)	UL/DL BW (MHz)	UL L _{CRB}	DL F _c (MHz)	MSD (dB)	IMD order
CA_n5A_n77A	5	844	5	25	889	8.3	IMD4
	n77	3421	10	50	3421	N/A	N/A
CA_n5A_n77A	5	829	5	25	875	[5.5]	IMD5
	n77	3600	10	50	3600	N/A	N/A

6.70 CA_n66-n77

6.70.1 Common for 1 band UL and 2 bands UL CA

6.70.1.1 Operating bands for CA

Table 6.70.1.1-1: DC band combination of band n66+n77

NR CA Band	NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
		BS receive / UE transmit		BS transmit / UE receive			
		F_{UL_low} – F_{UL_high}	F_{DL_low} – F_{DL_high}	F_{DL_low} – F_{DL_high}	F_{UL_low} – F_{UL_high}		
CA_n66-n77	n66	1710 MHz – 1780 MHz	2110 MHz – 2200 MHz	2110 MHz – 2200 MHz	1710 MHz – 1780 MHz	FDD	
	n77	3300 MHz – 4200 MHz	TDD				

6.70.1.2 Channel bandwidths per operating band for CA

Table 6.70.1.2-1: Supported NR bandwidths per CA configuration of band n66+n77

		DC operating / channel bandwidth															BCS
NR CA Configuration	UL CA Configuration	Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	70 MHz	80 MHz	90 MHz	100 MHz	
CA_n66A-n77A	CA_n66A-n77A	n66	15	Yes	Yes	Yes	Yes	Yes	Yes	Yes							0
			30		Yes	Yes	Yes	Yes	Yes	Yes							
			60		Yes	Yes	Yes	Yes	Yes	Yes							
	n77	n77	15		Yes												
			30		Yes												
			60		Yes												

6.70.1.3 UE co-existence studies

Table 6.70.1.3-1 and Table 6.70.1.3-2 capture the UL 2nd, 3rd, 4th, 5th harmonics and harmonic mixing for CA_n66A-n77A.

Table 6.70.1.3-1: Band n66 and Band n77 UL harmonics products

Band	2nd Harmonic 3rd Harmonic 4th Harmonic 5th Harmonic													
	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n66	1710	1780	2110	2200	3420	3560	5130	5340	6840	7120	8550	8900		
n77	3300	4200	3300	4200	6600	8400	9900	12600	16800	16800	16500	21000		

Table 6.70.1.3-2: Band n2 and Band n77 Harmonic mixing products

Band	2nd Harmonic 3rd Harmonic 4th Harmonic 5th Harmonic													
	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n66	1710	1780	2110	2200	4220	4400	6330	6600	8440	8800	10550	8900		
n77	3300	4200	3300	4200	6600	8400	9900	12600	13200	16800	16500	21000		

In analysis, it could be seen,

- The 2nd harmonic from band n66 UL may fall into band n77 DL frequency range
- No harmonic mixing products will fall into band n77 DL frequency range

6.70.1.4 $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values

For CA_n66-n77, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are given in the tables below.

Table 6.70.1.4-1: $\Delta T_{IB,c}$

Inter-band DA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n66-n77	n66	0.6
	n77	0.8

Table 6.70.1.4-2: $\Delta R_{IB,c}$

Inter-band DC Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n66-n77	n66	0.2
	n77	0.5

6.70.1.5 REFSENS requirements

MSD values for Band n77 due to 2nd harmonic of Band n66 in CA_n66A-n77A are captured in Table 6.70.1.5-1.

Table 6.70.1.5-1: MSD due to UL harmonic issue for CA_n66-n77

UL band	NR Band / Channel bandwidth of the affected DL band / MSD													
	DL band	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	30 MHz (dB)	40 MHz (dB)	50 MHz (dB)	60 MHz (dB)	70 MHz (dB)	80 MHz (dB)	90 MHz (dB)	100 MHz (dB)
n66	n77 ^{1,2}		23.9	22.1	20.9	19.8	19.0	17.9	16.8	16.0	15.3	14.8	14.3	13.8
	n77 ³		1.1	0.8	0.3	0.1	0	0	0	0	0	0	0	0
NOTE 1: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (lower) band for which the 2nd transmitter harmonic is within the downlink transmission bandwidth of a victim (higher) band and a range ΔF_{HD} above and below the edge of this downlink transmission bandwidth. The value ΔF_{HD} depends on the band combination: $\Delta F_{HD} = 10$ MHz for CA_n1-n77, CA_n2-n78, CA_n3-n77, CA_n3-n78, CA_n2-n48, CA_n25-n78, CA_n48-n66, CA_n66-n78, CA_n66-n77. NOTE 2: The requirements should be verified for UL EARFCN or NR ARFCN of the aggressor (lower) band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.2 \rfloor + 0.1$ in MHz and $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$ with carrier frequency in the victim (higher) band in MHz and the channel bandwidth configured in the lower band. NOTE 3: The requirements are only applicable to channel bandwidths no larger than 20 MHz and with a carrier frequency at $\pm (20 + BW_{Channel}^{HB} / 2)$ MHz offset from $2f_{UL}^{LB}$ in the victim (higher band) with $F_{UL_low}^{LB} + BW_{Channel}^{LB} / 2 \leq f_{UL}^{LB} \leq F_{UL_high}^{LB} - BW_{Channel}^{LB} / 2$, where $BW_{Channel}^{HB}$ and $BW_{Channel}^{LB}$ are the channel bandwidths configured in the aggressor (lower) and victim (higher) bands in MHz, respectively.														

The uplink configuration for reference sensitivity exceptions due to UL harmonic interference for CA_n66A-n77A are captured in Table 6.70.1.5-2.

Table 6.70.1.5-2 Uplink configuration due to UL harmonic interference

NR Band / Channel bandwidth of the affected DL band / UL RB allocation of the aggressor band														
UL band	DL band	5 MHz (LCRB)	10 MHz (LCRB)	15 MHz (LCRB)	20 MHz (LCRB)	25 MHz (LCRB)	30 MHz (LCRB)	40 MHz (LCRB)	50 MHz (LCRB)	60 MHz (LCRB)	70 MHz (LCRB)	80 MHz (LCRB)	90 MHz (LCRB)	100 MHz (LCRB)
n66	n77	25	36	50	64	80	100	100	100	100	100	100	100	100

6.70.2 Specific for 2 bands UL CA

6.70.2.1 UE co-existence studies

Table 6.70.2.1-1 lists Band n66 +Band n77 2UL CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.70.2.1-1: Band n66 and Band n77 2 UL bands IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	1710	1780	3300	4200
Two tone 2 nd order IMD products	fy_low – fx_high	fy_high – fx_low	fx_low + fy_low	fx_high + fy_high
IMD frequency limits (MHz)	1520	2490	5010	5980
Two-tone 3 rd order IMD products	2*fx_low – fy_high	2*fx_high – fy_low	2*fy_low – fx_high	2*fy_high – fx_low
IMD frequency limits (MHz)	780	260	4820	6690
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	6720	7760	8310	10180
Two-tone 4 th order IMD products	3*fx_low – fy_high	3*fx_high – fy_low	3*fy_low – fx_high	3*fy_high – fx_low
IMD frequency limits (MHz)	930	2040	8120	10890

Two-tone 4 th order IMD products	3*fx_low + fy_low	3*fx_high + fy_high	3*fy_low + fx_low	3*fy_high + fx_high
IMD frequency limits (MHz)	8430	9540	11610	14380
Two-tone 4 th order IMD products	2*fx_low - 2*fy_high	2*fx_high - 2*fy_low	2*fx_low + 2*fy_low	2*fx_high + 2*fy_high
IMD frequency limits (MHz)	4980	3040	10020	11960
Two-tone 5 th order IMD products	fx_low - 4*fy_high	fx_high - 4*fy_low	fy_low - 4*fx_high	fy_high - 4*fx_low
IMD frequency limits (MHz)	15090	11420	3820	2640
Two-tone 5 th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
IMD frequency limits (MHz)	14910	18580	10140	11320
Two-tone 5 th order IMD products	2*fx_low - 3*fy_high	2*fx_high - 3*fy_low	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)	9180	6340	1260	3270
Two-tone 5 th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high
IMD frequency limits (MHz)	13320	16160	11730	13740

In analysis, it could be seen,

- The 2nd and 5th order IMD products of Band n66 UL and Band n77 UL may fall into band n66 DL frequency range

The MSD should be considered to mitigate the impact of the interference for this combination.

Table 6.70.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.70.2.1-2: Protected bands for the 2UL bands DC configuration

EN-DC Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n66-n77	E-UTRA Band 2, 4, 5, 12, 13, 14, 17, 26, 29, 30, 41, 65, 66, 70, 71	F _{DL_low}	-	F _{DL_high}	-50	1

6.70.2.2 REFSENs requirements

Based on above coexistence study, two-tone 2nd order IMD products may fall into the own Rx Band of Band n66. And two-tone 5th order IMD products may fall into Rx Band of Band n66. The MSD for IMD2 and IMD5 are

Table 6.70.2.2-1 lists the MSD required for the dual connectivity configuration due to IMD2 and IMD5.

Table 6.70.2.2-1: MSD due to IMD issue

Operating Band / Channel bandwidth / N _{RB} / Duplex mode							Source of IMD	
NR CA Configuration	NR band	UL F _c (MHz)	UL/DL BW (MHz)	UL C _{LRB}	DL F _c (MHz)	MSD (dB)		
CA_n66A-n77A	n66	1775	5	25	2175	31	FDD	IMD2
	n77	3950	10	50	3950	N/A	TDD	N/A
	n66	1730	5	25	2130	5.0	FDD	IMD5
	n77	3660	10	50	3660	N/A	TDD	N/A

6.71 CA_n38-n78

6.71.1 Common for 1 band UL and 2 bands UL CA

6.71.1.1 Operating bands for CA

Table 6.71.1.1-1: CA band combination of band n38+n78

NR CA Band	NR Band	Uplink (UL) band				Downlink (DL) band				Duplex mode	
		BS receive / UE transmit				BS transmit / UE receive					
		$F_{UL_low} - F_{UL_high}$				$F_{DL_low} - F_{DL_high}$					
CA_n38A-n78A	n38	2570 MHz	–	2620 MHz		2570 MHz	–	2620 MHz		TDD	
	n78	3300 MHz	–	3800 MHz		3300 MHz	–	3800 MHz		TDD	
NOTE 1: Applicable for UE supporting inter-band carrier aggregation with mandatory simultaneous Rx/Tx capability.											

6.71.1.2 Channel bandwidths per operating band for CA

Table 6.71.2-1: Supported bandwidths per CA band combination of band n38+n78

CA operating / channel bandwidth [MHz]																	
NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5	10	15	20	25	30	40	50	60	70	80	90	100	Bandwidth combination set
CA_n38A-n78A	CA_n38A-n78A	n38	15	Yes	Yes	Yes	Yes										0
			30		Yes	Yes	Yes										
			60		Yes	Yes	Yes										
	n78	n78	15		Yes	Yes	Yes	Yes	Yes	Yes	Yes						0
			30		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes	
			60		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes	
CA_n38A-n78(2A)	CA_n38A-n78A	n38	15	Ye s	Ye s	Ye s	Ye s										0
			30		Ye s	Ye s	Ye s										
			60		Ye s	Ye s	Ye s										
	n78		See CA_n78(2A) Bandwidth Combination in Table 5.5A.2-1														

6.71.1.3 Co-existence studies

Table 6.71.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n38-n78.

Table 6.71.1.3-1: Impact of UL/DL Harmonic

						2nd Harmonic		3rd Harmonic		nth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge		UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n38	2570	2620	2570	2620	5140	5240	7710	7860			
n78	3300	3800	3300	3800	6600	7600	9900	11400			

Based on above table, there is no harmonic issue for the band combination of n38 and n78.

Table 6.71.1.3-2: Impact of UL/DL Harmonic mixing

						2nd Harmonic		3rd Harmonic		nth Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge		UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n38	2570	2620	2570	2620	5140	5240	7710	7860			
n78	3300	3800	3300	3800	6600	7600	9900	11400			

Based on above table, there is no harmonic mixing issue for the band combination of n38 and n78.

6.71.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n38-n78, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below which are reused from DC_38-n78.

Table 6.71.1.4-1: $\Delta T_{IB,c}$

NR CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n38-n78	n38	0.3
	n78	0.8

Table 6.71.1.4-2: $\Delta R_{IB,c}$

NR CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n38-n78	n38	0.4
	n78	0.5

6.71.1.5 REFSEN requirements

According to the analysis in subclause 6.71.1.3, there are no harmonic issues for this combination. Hence it is no need to define the MSD values caused by harmonic issues for NR CA n38+n78 band combination.

6.71.2 Specific for 2 bands UL CA

6.71.2.1 UE co-existence studies

Table 6.71.2.1-1 lists Band n38 +Band n78 2UL CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.71.2.1-1: Band n38 and Band n78 UL IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency	2570	2620	3300	3800
2 nd order IMD products	fy_low-fx_high	fy_high-fx_low	fy_low+fx_low	fy_high+fx_high
IMD frequency limits (MHz)	680	1230	5870	6420
Two-tone 3 rd order IMD products	fy_high - 2*fx_low	fy_low - 2*fx_high	2*fy_low - fx_high	2*fy_high - fx_low
IMD frequency limits (MHz)	1340	1940	3980	5030
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	8440	9040	9170	10220
Two-tone 4th order IMD products	2*fx_low - 2* fy_high	2*fx_high - 2*fy_low	2*fx_low + 2* fy_low	2*fx_high + 2* fy_high
IMD frequency limits (MHz)	2460	1360	11740	12840
Two-tone 4th order IMD products	3*fx_low - 1* fy_high	3*fx_high - 1*fy_low	3*fy_low - 1*fx_high	3*fy_high - 1*fx_low
IMD frequency limits (MHz)	3910	4560	7280	8830
Two-tone 4th order IMD products	3*fx_low + 1* fy_low	3*fx_high + 1*fy_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high
IMD frequency limits (MHz)	11010	11660	12470	14020
Two-tone 5th order IMD products	fx_low - 4*fy_high	fx_high - 4*fy_low	fy_low - 4*fx_high	fy_high - 4*fx_low

IMD frequency limits (MHz)	12630	10580	7180	6480
Two-tone 5th order IMD products	$ fx_{low} + 4*fy_{low} $	$ fx_{high} + 4*fy_{high} $	$ fy_{low} + 4*fx_{low} $	$ fy_{high} + 4*fx_{high} $
IMD frequency limits (MHz)	15770	17820	13580	14280
Two-tone 5th order IMD products	$ 2*fx_{low} - 3*fy_{high} $	$ 2*fx_{high} - 3*fy_{low} $	$ 2*fy_{low} - 3*fx_{high} $	$ 2*fy_{high} - 3*fx_{low} $
IMD frequency limits (MHz)	6260	4660	1260	110
Two-tone 5th order IMD products	$ 2*fx_{low} + 3*fy_{low} $	$ 2*fx_{high} + 3*fy_{high} $	$ 2*fy_{low} + 3*fx_{low} $	$ 2*fy_{high} + 3*fx_{high} $
IMD frequency limits (MHz)	15040	16640	14310	15460
NOTE : For each IMD item, when two bound values before taking absolute have different signs, the relevant IMD range shall be set such that (1) the lower bound is 0 and (2) the upper bound is the bigger value of the two after taking absolute.				

Since both band n38 and band n78 are belong to TDD band, therefore IMD is not an issue for TDD bands combination (no self-interference for the TDD band), there is no MSD issue for this band combination.

Table 6.71.2.2-2 lists the protected bands required for the 2UL bands CA configuration.

Table 6.71.2.2-1: Protected bands for the 2UL bands CA configuration

NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n38-n78	E-UTRA Band 1, 3, 5, 8, 20, 28, 34, 40, 65,	F_{DL_low}	-	F_{DL_high}	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3
	Frequency range	2620	-	2645	-15.5	5
	Frequency range	2645	-	2690	-40	1
NOTE 3: Applicable when co-existence with PHS system operating in 1884.5 -1915.7 MHz						
NOTE 15: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.						
NOTE 22: This requirement is applicable for power class 3 UE for any channel bandwidths within the range 2570 - 2615 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 2605.5 - 2607.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 2597 - 2605 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB. For power class 2 UE for any channel bandwidths within the range 2570 - 2615 MHz, NS_44 shall apply. For power class 2 or 3 UE for carriers with channel bandwidth overlapping the frequency range 2615 - 2620 MHz the requirement applies with the maximum output power configured to +19 dBm in the IE P-Max.						
NOTE 26: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.						

6.71.2.2 REFSENS requirements

As IMD is not an issue for TDD bands combination, there is no MSD issue caused by IMD for this combination.

In addition, since only asynchronous operation with supporting simultaneous Tx/Rx is considered for this combination, MSD due to cross band isolation need to be specified. The following MSD due to lack of cross band isolation is proposed to add to Table 6.71.2.2-1 and Table 6.71.2.2-2 in TS 38.101-1. The values are reused from DC_41-n78.

Table 6.71.2.2-1: MSD for the CA configuration for asynchronous operation and cross band isolation for CA

NR Band / Channel bandwidth of the affected DL band															
NR CA Configuration	UL band	DL band	5 MHz (dB)	10 MHz (dB)	15 MHz (dB)	20 MHz (dB)	25 MHz (dB)	30 MHz (dB)	40 MHz (dB)	50 MHz (dB)	60 MHz (dB)	70 MHz (dB)	80 MHz (dB)	90 MHz (dB)	100 MHz (dB)
CA_n38A-n78A CA_n38A-n78(2A)	n38	n78		8.3	8.3	8.3	7.3	6.5	6.3	5.3	4.5		4.0	3.9	3.8
	n78	n38	3.3	3.3	3.3	3.3									

Table 6.71.2.2-2: Uplink configuration for reference sensitivity exceptions due to cross band isolation for CA

NR Band / SCS / Channel bandwidth of the affected DL band															
UL band	DL band	SCS of UL band (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	70 MHz	80 MHz	90 MHz	100 MHz
n38	n78	15		100	100	100	100	100	100	100	100		100	100	100
n78	n38	30	270	270	270	270									

6.72 n5-n7

6.72.1 Common for 1 band UL and 2 bands UL CA

6.72.1.1 Operating bands for CA

Table 6.72.1.1-1: CA band combination of band n5 and n7

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
	BS receive / UE transmit			BS transmit / UE receive				
	$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$				
n5	824 MHz – 849 MHz			869 MHz – 894 MHz			FDD	
n7	2500 MHz – 2570 MHz			2620 MHz – 2690 MHz			FDD	

6.72.1.2 Channel bandwidths per operating band for CA

Table 6.72.1.2-1: Supported bandwidths per CA band combination of band n5 and n7

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Bandwidth combination set
CA_n5A-n7A	-	n5	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60													
		n7	15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes					0
			30		Yes											
			60		Yes											
		n5	15	Yes	Yes	Yes	Yes									0
			30		Yes	Yes	Yes									
			60													
		n7	See CA_n7B Bandwidth Combination Set 0 in Table 5.5A.1-1													

6.72.1.3 UE co-existence studies

Table 6.72.1.3-1 lists up to 7th harmonics for n5-n7. As can be seen there are no harmonic issues.

Table 6.72.1.3-1: Impact of UL/DL Harmonic

	2 nd Harmonic		3 rd Harmonic		4 th Harmonic		5 th Harmonic		6 th Harmonic		7 th Harmonic			
Band	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge		
n5	824	849	1648	1698	2472	2547	3296	3396	4120	4245	4944	5094	5768	5943
n7	2500	2570	5000	5140	7500	7710	10000	10280	12500	12850	15000	15420	17500	17990

Table 6.72.1.3-2 list harmonic mixing issue for the 2DL bands CA with 1 UL. As can be seen there are no harmonic mixing issues.

Table 6.72.1.3-2 Harmonic mixing for 2DLs/1UL

					2 nd Harmonic		3 rd Harmonic		4 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n5	824	849	869	894	1738	1788	2607	2682	3476	3576
n7	2500	2570	2620	2690	5240	5380	7860	8070	10480	10760

6.72.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n5-n7, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are same as for DC_5_n7 and are given in the tables below.

Table 6.72.1.4-1: $\Delta T_{IB,c}$

NR CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n5-n7	n5	0.3
	n7	0.3

Table 6.72.1.4-2: $\Delta R_{IB,c}$

NR CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n5-n7	n5	0
	n7	0

6.72.1.5 REFSENS requirements

As can be seen in the co-existence studies in 6.72.1.3 there are no harmonics issues.

6.73 n3-n7

6.73.1 Common for 1 band UL and 2 bands UL CA

6.73.1.1 Operating bands for CA

Table 6.73.1.1-1: CA band combination of band n3 and n7

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
	BS receive / UE transmit			BS transmit / UE receive				
	$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$				
n3	1710 MHz	–	1785 MHz	1805 MHz	–	1880 MHz	FDD	
n7	2500 MHz	–	2570 MHz	2620 MHz	–	2690 MHz	FDD	

6.73.1.2 Channel bandwidths per operating band for CA

Table 6.73.1.2-1: Supported bandwidths per CA band combination of band n3 and n7

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Bandwidth combination set	
CA_n3A-n7A	CA_n3A-n7A	n3	15	Yes	Yes	Yes	Yes	Yes	Yes							0	
			30		Yes	Yes	Yes	Yes	Yes								
			60		Yes	Yes	Yes	Yes	Yes								
		n7	15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes						
			30		Yes												
			60		Yes												
CA_n3A-n7B	-	n3	15	Yes	Yes	Yes	Yes	Yes	Yes							0	
			30		Yes	Yes	Yes	Yes	Yes								
			60		Yes	Yes	Yes	Yes	Yes								
		n7	See CA_n7B Bandwidth Combination Set 0 in Table 5.5A.1-1														

6.73.1.3 UE co-existence studies

Table 6.73.1.3-1 lists up to 7th harmonics for n3-n7. As can be seen there are no harmonic issues.

Table 6.73.1.3-1: Impact of UL/DL Harmonic

			2 nd Harmonic		3 rd Harmonic		4 th Harmonic		5 th Harmonic		6 th Harmonic		7 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge												
n3	1710	1785	3420	3570	5130	5355	6840	7140	8550	8925	10260	10710	11970	12495
n7	2500	2570	5000	5140	7500	7710	10000	10280	12500	12850	15000	15420	17500	17990

Table 6.73.1.3-2 list harmonic mixing issue for the 2DL bands CA with 1 UL. As can be seen there are no harmonic mixing issues.

Table 6.73.1.3-2 Harmonic mixing for 2DLs/1UL

							2 nd Harmonic		3 rd Harmonic		4 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge	DL Low Band Edge	DL High Band Edge
n3	1710	1785	1805	1880	3610	3760	5415	5640	7220	7520		
n7	2500	2570	2620	2690	5240	5380	7860	8070	10480	10760		

6.73.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n3-n7, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are same as for DC_3_n7 and are given in the tables below.

Table 6.73.1.4-1: $\Delta T_{IB,c}$

NR CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n3-n7	n3	0.5
	n7	0.5

Table 6.73.1.4-2: $\Delta R_{IB,c}$

NR CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n3-n7	n3	0
	n7	0

6.73.1.5 REFSENS requirements

As can be seen in the co-existence studies in 6.73.1.3 there are no harmonics issues.

6.73.2 Specific for 2 bands UL CA

6.73.2.1 UE co-existence studies

Table 6.73.2.1-1 lists Band n3 + Band n7 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.73.2.1-1: Band n3 and Band n7 UL IMD products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	1710	1785	2500	2570
2nd harmonics frequency limits	$2 * fy_{low}$	$2 * fy_{high}$	$2 * fx_{low}$	$2 * fx_{high}$
2nd harmonics frequency limits (MHz)	3420	3570	5000	5140
3rd harmonics frequency limits	$3 * fy_{low}$	$3 * fy_{high}$	$3 * fx_{low}$	$3 * fx_{high}$
3rd harmonics frequency limits (MHz)	5130	5355	7500	7710
4th harmonics frequency limits	$4 * fy_{low}$	$4 * fy_{high}$	$4 * fx_{low}$	$4 * fx_{high}$
4th harmonics frequency limits (MHz)	6840	7140	10000	10280
5th harmonics frequency limits	$5 * fy_{low}$	$5 * fy_{high}$	$5 * fx_{low}$	$5 * fx_{high}$
5th harmonics frequency limits (MHz)	8550	8925	12500	12850
6th harmonics frequency limits	$6 * fy_{low}$	$6 * fy_{high}$	$6 * fx_{low}$	$6 * fx_{high}$
6th harmonics frequency limits (MHz)	10260	10710	15000	15420
7th harmonics frequency limits	$7 * fy_{low}$	$7 * fy_{high}$	$7 * fx_{low}$	$7 * fx_{high}$
7th harmonics frequency limits (MHz)	11970	12495	17500	17990
2nd order IMD products	$ fy_{high} - fx_{low} $	$ fy_{low} - fx_{high} $	$ fy_{low} + fx_{low} $	$ fy_{high} + fx_{high} $
IMD frequency limits (MHz)	860	715	4210	4355
3rd order IMD products	$ fy_{high} - 2 * fx_{low} $	$ fy_{low} - 2 * fx_{high} $	$ 2 * fy_{low} - fx_{high} $	$ 2 * fy_{high} - fx_{low} $
IMD frequency limits (MHz)	850	1070	3215	3430
3rd order IMD products	$ 2 * fx_{low} + fy_{low} $	$ 2 * fx_{high} + fy_{high} $	$ 2 * fy_{low} + fx_{low} $	$ 2 * fy_{high} + fx_{high} $
IMD frequency limits (MHz)	5920	6140	6710	6925
Two-tone 4th order IMD products	$ 2 * fx_{low} - 2 * fy_{high} $	$ 2 * fx_{high} - 2 * fy_{low} $	$ 2 * fx_{low} + 2 * fy_{low} $	$ 2 * fx_{high} + 2 * fy_{high} $
IMD frequency limits (MHz)	1720	1430	8420	8710
Two-tone 4th order IMD products	$ 3 * fx_{low} - 1 * fy_{high} $	$ 3 * fx_{high} - 1 * fy_{low} $	$ 3 * fy_{low} - 1 * fx_{high} $	$ 3 * fy_{high} - 1 * fx_{low} $
IMD frequency limits (MHz)	2560	2855	5715	6000
Two-tone 4th order IMD products	$ 3 * fx_{low} + 1 * fy_{low} $	$ 3 * fx_{high} + 1 * fy_{high} $	$ 3 * fy_{low} + 1 * fx_{low} $	$ 3 * fy_{high} + 1 * fx_{high} $
IMD frequency limits (MHz)	7630	7925	9210	9495
Two-tone 5th order IMD products	$ fx_{low} - 4 * fy_{high} $	$ fx_{high} - 4 * fy_{low} $	$ fy_{low} - 4 * fx_{high} $	$ fy_{high} - 4 * fx_{low} $
IMD frequency limits (MHz)	8570	8215	4640	4270
Two-tone 5th order IMD products	$ fx_{low} + 4 * fy_{low} $	$ fx_{high} + 4 * fy_{high} $	$ fy_{low} + 4 * fx_{low} $	$ fy_{high} + 4 * fx_{high} $
IMD frequency limits (MHz)	11710	12065	9340	9710
Two-tone 5th order IMD products	$ 2 * fx_{low} - 3 * fy_{high} $	$ 2 * fx_{high} - 3 * fy_{low} $	$ 2 * fy_{low} - 3 * fx_{high} $	$ 2 * fy_{high} - 3 * fx_{low} $
IMD frequency limits (MHz)	4290	3930	355	10
Two-tone 5th order IMD products	$ 2 * fx_{low} + 3 * fy_{low} $	$ 2 * fx_{high} + 3 * fy_{high} $	$ 2 * fy_{low} + 3 * fx_{low} $	$ 2 * fy_{high} + 3 * fx_{high} $
IMD frequency limits (MHz)	10920	11280	10130	10495

Based on Table 6.73.2.1-1 there are IMD4 affecting own Rx frequencies of band n7.

Table 6.73.2.1-2 lists the protected bands required for the 2UL bands CA configuration as to be used in Table 6.5A.3.2.3-1 of TS 38.101-1, and with same bands as for DC_3_n7 in TS 38.101-3.

Table 6.73.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n3-n7	E-UTRA Band 1, 5, 7, 8, 20, 26, 27, 28, 31, 32, 33, 34, 40, 43, 44, 50, 51, 65, 67, 72, 74, 75, 76	F _{DL_low}	-	F _{DL_high}	-50	1
	E-UTRA band 3	F _{DL_low}	-	F _{DL_high}	-50	1
	E-UTRA band 22, 42, 52 NR-band n77, n78	F _{DL_low}	-	F _{DL_high}	-50	1
	Frequency range	2570	-	2575	+1.6	5
	Frequency range	2575	-	2595	-15.5	5
	Frequency range	2595	-	2620	-40	1
<p>NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of $(2 \text{ MHz} + N \times L_{\text{CRB}} \times 180\text{kHz})$, where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.</p> <p>NOTE 4: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.</p> <p>NOTE 7: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.</p> <p>NOTE 18: This requirement is applicable for any channel bandwidths within the range 2500 – 2570 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 2560.5 - 2562.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 2552 – 2560 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB.</p>						

6.73.2.2 REFSENS requirements

There is a need to define IMD4 MSD for CA_n3-n7. Same MSD values as for DC_3_n7.

Table 6.73.2.2-1: 2DL/2UL interband Reference sensitivity QPSK P_{REFSENS} and uplink/downlink configurations

Band / Channel bandwidth / N _{RB} / Duplex mode								Source of IMD
NR CA Configuration	NR band	UL F _c (MHz)	UL/DL BW (MHz)	UL C _{LRB}	DL F _c (MHz)	MSD (dB)	Duplex mode	
CA_n3A-n7A	n3	1730	5	25	1825	N/A	FDD	N/A
	n7	2535	10	50	2655	10.2	FDD	IMD4

7 Both bands within FR2 Carrier Aggregation: Specific Band Combination Part

7.x CA_nX-nY

7.x.1 Common for 1 band UL and 2 bands UL CA

7.x.1.1 Operating bands for CA

Table 7.x.1.1-1: CA band combination of band nX+nY

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
	BS receive / UE transmit		BS transmit / UE receive			
	$F_{UL_low} - F_{UL_high}$	$F_{DL_low} - F_{DL_high}$				
nX	—	—	—	—		
nY	—	—	—	—		

7.x.1.2 Channel bandwidths per operating band for CA

Table 7.x.1.2-1: Supported bandwidths per CA band combination of band nX+nY

NR CA configuration / Bandwidth combination set											
NR CA configuration	Uplink configuration	NR Band	SCS (kHz)	50 MHz	100 MHz	200 MHz	400 MHz	Maximum Aggregated bandwidth [MHz]	Bandwidth combination set		
CA_nXA-nYA	-	nX	60	—	—	—	—	0	0		
			120	—	—	—	—				
		nY	60	—	—	—	—				
			120	—	—	—	—				
CA_nXA-nYC	CA_nXA-nYA	nX	60	—	—	—	—	0	0		
			120	—	—	—	—				
		nY	60	See CA_nYC Bandwidth combination set 0 in table 5.5A.1-1 of 38.101-2							
			120	See CA_nYC Bandwidth combination set 0 in table 5.5A.1-1 of 38.101-2							
CA_nXC-nYA	CA_nXC	nX	60	See CA_nXC Bandwidth combination set 0 in table 5.5A.1-1 of 38.101-2				0	0		
			120	See CA_nXC Bandwidth combination set 0 in table 5.5A.1-1 of 38.101-2							
		nY	60	—	—	—	—				
			120	—	—	—	—				
CA_nX(2A)-nYA	-	nX	60	See CA_nX(2A) Bandwidth combination set 0 in table 5.5A.2-1 of 38.101-2				0	0		
			120	See CA_nX(2A) Bandwidth combination set 0 in table 5.5A.2-1 of 38.101-2							
		nY	60	—	—	—	—				
			120	—	—	—	—				

7.x.1.3 UE co-existence studies

< Editor's note: Text will be added, the examples is given as follows. The harmonics issues shoule be analysed based on this table. >

Table 7.x.1.3-1 lists up to n^{th} harmonics for CA_nX-nY.

Table 7.x.1.3-1: Impact of UL/DL Harmonic

			2 nd Harmonic		3 rd Harmonic		n th Harmonic	
Band	UL Low Ban d Edg e	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
nX								
nY								

7.x.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_nX-nY, the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 7.x.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_nX-nY	nX	
	nY	

Table 7.x.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_nX-nY	nX	
	nY	

7.x.1.5 REFSENS requirements

< Editor's note: Text will be added if harmonics issues are identified, and only REFSENS numbers for bands have these issues need to be provided in the table. >

7.x.2 Specific for 2 bands UL CA

< Editor's note: Text will be added if 2 bands UL CA are supported, otherwise all the clauses shall be void. >

7.x.2.1 UE co-existence studies

< Editor's note: Text will be added. >

7.x.2.2 REFSENS requirements

< Editor's note: Text will be added if IMD due to 2 bands UL issues are identified. >

8 FR1+FR2 Carrier Aggregation: Specific Band Combination Part

8.1 CA_n71_n261

8.1.1 Common for 1 band UL and 2 bands UL

8.1.1.1 Channel bandwidths per operating band for CA

Table 8.1.1-1: CA band combination of band n71 + n261

NR CA Band Combination	NR Band	Uplink (UL) band				Downlink (DL) band				Duplex mode	
		BS receive / UE transmit				BS transmit / UE receive					
		$F_{UL_low} - F_{UL_high}$				$F_{DL_low} - F_{DL_high}$					
CA_n71-n261	n71	663 MHz –		698 MHz		617 MHz –		652 MHz		FDD	
	n261	27500 MHz –		28350 MHz		27500 MHz –		28350 MHz		TDD	

Table 8.1.1-2: Supported bandwidths per CA band combination of CA_n71A-n261A

CA operating / channel bandwidth														
NR CA Configuration	NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	200 MHz	400 MHz	Maximum aggregated bandwidth [MHz]
CA_n71A-n261A	n71	15	Yes	Yes	Yes	Yes								420
		30		Yes	Yes	Yes								
	n261	60						Yes			Yes	Yes		
		120						Yes			Yes	Yes	Yes	
CA_n71A-n261(2A)	n71	15	Yes	Yes	Yes	Yes								820
		30		Yes	Yes	Yes								
	n261	See CA_n261(2A) BCS 0 in Table 5.5A.2-1 in TS 38.101-2												

8.1.1.2 UE co-existence studies

Table 8.1.2-1 gives the UL 2nd, 3rd, 4th, 5th, 6th, 7th harmonic for CA_n71A-n261A.

Table 8.1.2-1: Band n71 and Band n261 UL harmonics products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	663	698	27500	28350
2 nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1326	1396	55000	56700
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	1989	2094	82500	85050
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	2652	2792	110000	113400
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	3315	3490	137500	141750
6th harmonics frequency limits	6*fx_low	6*fx_high	6* fy_low	6* fy_high
6th harmonics frequency limits (MHz)	3978	4188	165000	170100
7th harmonics frequency limits	7*fx_low	7*fx_high	7* fy_low	7* fy_high
7th harmonics frequency limits (MHz)	4641	4886	192500	198450

From table 8.1.2-1 it can be seen that UL harmonic frequencies of Band n71 and Band n261 do not locate within the UE's own receive bands, therefore it can be concluded that there is no issue on harmonic interference.

8.1.1.3 ΔT_{IB} and ΔR_{IB} values

For CA_n71A-n261A, the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 8.1.3-1: $\Delta T_{IB,c}$

NR inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n71A-n261A	n71	0
	n261	0

Table 8.1.3-2: $\Delta R_{IB,c}$

NR inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n71A-n261A	n71	0
	n261	0

8.1.1.4 REFSENS requirements

There is no specific REFSENS requirement.

8.2 CA_n71-n260

8.2.1 Common for 1 band UL and 2 bands UL CA

8.2.1.1 Operating bands for CA

Table 8.2.1.1-1: CA band combination of band nX+nY

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
	BS receive / UE transmit			BS transmit / UE receive				
	$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$				
n71	663 MHz – 698 MHz			617 MHz – 652 MHz			FDD	
n260	37000 MHz – 40000 MHz			37000 MHz – 40000 MHz			TDD	

8.2.1.2 Channel bandwidths per operating band for CA

Table 8.2.1.2-1: Supported bandwidths per CA band combination of band nX+nY

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	200 MHz	400 MHz	Band width combination set
CA_n71A-n260A	-	n71	15	Yes	Yes	Yes	Yes								0
			30		Yes	Yes	Yes								
			60												
		n260	60						Yes			Yes	Yes		0
			120						Yes			Yes	Yes	Yes	
		n71	15	Yes	Yes	Yes	Yes								
CA_n71A-n260(2A)	-	n71	30		Yes	Yes	Yes								0
			60												
			120												
		n260	15	Yes	Yes	Yes	Yes								0
			30		Yes	Yes	Yes								
			60												
				See CA_n260(2A) in Table 5.5A.2-1 of TS 38.101-2											

8.2.1.3 UE co-existence studies

Table 8.2.1.3-1 lists up to 7th harmonics for CA_n71A-n260A.

Table 8.2.1.3-1: Impact of UL/DL Harmonic

			2 nd Harmonic		3 rd Harmonic		4 th Harmonic		5 th Harmonic		6 th Harmonic		7 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge												
n71	663	698	1326	1396	1989	2094	2652	2792	3315	3490	3978	4188	4641	4886
n260	3700	40000	74000	80000	111 k	120 k	148 k	160 k	185 k	200 k	222 k	240 k	259 k	280 k

8.2.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n71A-n260, the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 8.2.1.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
CA_n71-n260	n71	0
	n260	0

Table 8.2.1.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
CA_n71-n260	n71	0
	n260	0

8.2.1.5 REFSENS requirements

There is no need for additional REFSENS requirements.

8.3 CA_n41-n261

8.3.1 Common for 1 band UL and 2 bands UL CA

8.3.1.1 Operating bands for CA

Table 8.3.1.1-1: CA band combination of band n41+n261

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
	BS receive / UE transmit		BS transmit / UE receive			
	$F_{UL_low} - F_{UL_high}$		$F_{DL_low} - F_{DL_high}$			
n41	2496	– 2690	2496	– 2690	FDD	
n261	27500	– 28350	27500	– 28350	TDD	

8.3.1.2 Channel bandwidths per operating band for CA

Table 8.3.1.2-1: Supported bandwidths per CA band combination of band n41+n261

NR CA configuration	NR Uplink CA configuration	NR Band	SC S (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	200 MHz	400 MHz	Bandwidth combination set	
CA_n41A-n261A	n41	15		Yes	Yes	Yes			Yes	Yes								0	
		30		Yes	Yes	Yes			Yes										
		60		Yes	Yes	Yes			Yes										
		60								Yes					Yes	Yes			
	n261	120								Yes					Yes	Yes	Yes	0	
		15		Yes	Yes	Yes			Yes	Yes									
		30		Yes	Yes	Yes			Yes										
		60		Yes	Yes	Yes			Yes										
CA_n41A-n261(2A)	n41	n261		See CA_n261(2A) Bandwidth combination set in 38.101-2															
		n41		See Table 5.5A.1-1 CA_n41C BCS0 38.101-1															
		60								Yes					Yes	Yes		0	
		120								Yes					Yes	Yes	Yes		
CA_n41C-n261A	n41	n41		See Table 5.5A.2-1 CA_n41(2A) BCS1 in 38.101-1															
		60								Yes					Yes	Yes		0	
	n261	120								Yes					Yes	Yes	Yes		
		120								Yes					Yes	Yes	Yes		
CA_n41(2A)-n261(2A)	n41		See Table 5.5A.2-1 CA_n41(2A) BCS1 in 38.101-1															0	
	n261		See Table 5.5A.2-1 CA_n261(2A) BCS0 in 38.101-2																
CA_n41C-n261(2A)	n41		See Table 5.5A.2-1 CA_n41(2A) BCS1 in 38.101-1															0	
	n261		See Table 5.5A.2-1 CA_n261(2A) BCS0 in 38.101-2																

8.3.1.3 UE co-existence studies

Harmonic relation between FR1 and FR2 band is not analyzed due to large frequency separation.

The additional spurious emission level to coexisting bands is specified in Table 8.3.1.3-1.

Table 8.3.1.3-1: Requirements for uplink inter-band CA (two bands)

NR CA Configuration	Spurious emission							NOTE
	Protected band			Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	
CA_n41-n261	E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 24, 25, 26, 29, 30, 41, 48, 66, 70, 71, 85	F_{DL_low}	-	F_{DL_high}		-50	1	

8.3.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n41-n261, the $T_{IB,c}$ and $R_{IB,c}$ values are all zero and thus do not need to be explicitly specified in TS 38.101-3.

8.3.1.5 REFSENS requirements

There are no specific REFSENS requirements for 1 band UL.

8.4 CA_n25-n261

8.4.1 Common for 1 band UL and 2 bands UL CA

8.4.1.1 Operating bands for CA

Table 8.4.1.1-1: CA band combination of band n25+n261

NR Band	Uplink (UL) band				Downlink (DL) band				Duplex mode	
	BS receive / UE transmit				BS transmit / UE receive					
	$F_{UL_low} - F_{UL_high}$				$F_{DL_low} - F_{DL_high}$					
n25	1850 – 1910				1930 – 1995				FDD	
n261	27500 – 28350				27500 – 28350				TDD	

8.4.1.2 Channel bandwidths per operating band for CA

Table 8.4.1.2-1: Supported bandwidths per CA band combination of band n25+n261

NR CA configuration	NR Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	200 MHz	400 MHz	Bandwidth combination set
CA_n25A-n261A	-	n25	15	Yes	Yes	Yes	Yes											0
			30		Yes	Yes	Yes											
			60		Yes	Yes	Yes											
		n261	60								Yes					Yes	Yes	0
			120								Yes					Yes	Yes	
		n25	15	Yes	Yes	Yes	Yes											0
			30		Yes	Yes	Yes											
			60		Yes	Yes	Yes											
		n261	See CA_n261(2A) Bandwidth combination set in 38.101-2															

8.4.1.3 UE co-existence studies

Harmonic relation between FR1 and FR2 band is not analyzed due to large frequency separation.

The additional spurious emission level to coexisting bands is specified in Table 8.4.1.3-1.

Table 8.4.1.3-1: Requirements for uplink inter-band CA (two bands)

NR CA Configuration	Protected band	Spurious emission				NOTE
		Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	
CA_n25-n261	E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 24, 25, 26, 29, 30, 41, 48, 66, 70, 71, 85	F_{DL_low}	-	F_{DL_high}	-50	1

8.4.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n25-n261, the $T_{IB,c}$ and $R_{IB,c}$ values are all zero and thus do not need to be explicitly specified in TS 38.101-3.

8.4.1.5 REFSENS requirements

There are no specific REFSENS requirements for 1 band UL.

8.5 CA_n77-n258

8.5.1 Common for 1 band UL and 2 bands UL CA

8.5.1.1 Operating bands for CA

Table 8.5.1-1: CA band combination of band n77 + n258

NR CA Band Combination	NR Band	Uplink (UL) band					Downlink (DL) band					Duplex mode	
		BS receive / UE transmit					BS transmit / UE receive						
		$F_{UL_low} - F_{UL_high}$					$F_{DL_low} - F_{DL_high}$						
CA_n77-n258	n77	3300 MHz		–		4200 MHz		3300 MHz		–		TDD	
	n258	24250 MHz		–		27500 MHz		24250 MHz		–		TDD	

8.5.1.2 Channel bandwidths per operating band for CA

Table 8.5.2-1: Supported bandwidths per CA band combination of band n77+n258

NR CA configuration	UpLink CA configuration	NR Band	SCS (kH z)	5 MHz	10 MHz	15 MHz	20 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	200 MHz	400 MHz	Bandwidth combination set
CA_n77A-n258A	-	n77	15		Yes	Yes	Yes	Yes	Yes							0
			30		Yes											
			60		Yes											
		n258	60						Yes				Yes	Yes		
			120						Yes				Yes	Yes	Yes	

8.5.1.3 Co-existence studies

Table 8.5.3-1 gives the UL 2nd, 3rd, 4th, 5th, 6th, 7th harmonic for CA_n77A-n258A. The 6th and 7th harmonic produced by UL band n77 may fall into Band n258 DL.

Table 8.5.1.3-1: Band n77 and Band n258 UL harmonics products

UE UL carriers	fx_low	fx_high	<bfy_low< b=""></bfy_low<>	<bfy_high< b=""></bfy_high<>
UL frequency(MHz)	3300	4200	24250	27500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2*fy_low	2*fy_high
2nd harmonics frequency limits(MHz)	6600	8400	48500	55000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3*fy_low	3*fy_high
3rd harmonics frequency limits(MHz)	9900	12600	72750	82500
4th harmonics frequency limits	4*fx_low	4*fx_high	4*fy_low	4*fy_high
4th harmonics frequency limits(MHz)	13200	16800	97000	110000
5th harmonics frequency limits	5*fx_low	5*fx_high	5*fy_low	5*fy_high
5th harmonics frequency limits(MHz)	16500	21000	121250	137500
6th harmonics frequency limits	6*fx_low	6*fx_high	6*fy_low	6*fy_high
6th harmonics frequency limits(MHz)	19800	25200	145500	165000
7th harmonics frequency limits	7*fx_low	7*fx_high	7*fy_low	7*fy_high
7th harmonics frequency limits(MHz)	23100	29400	169750	192500

8.5.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n77A-n258A, the $T_{IB,c}$ and R_{IB} values are given in the tables below.

Table 8.5.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n77-n258	n77	0
	n258	0

Table 8.5.4-2: ΔR_{IB}

Inter-band CA Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
CA_n77-n258	n77	0
	n258	0

8.5.1.5 REFSENS requirements

There is no specific REFSENS requirement.

8.6 CA_n78-n258

8.6.1 Common for 1 band UL and 2 bands UL CA

8.6.1.1 Operating bands for CA

Table 8.6.1-1: CA band combination of band n78 + n258

NR CA Band Combination	NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
		BS receive / UE transmit		BS transmit / UE receive			
		F_{UL_low} – F_{UL_high}	F_{DL_low} – F_{DL_high}	F_{DL_low} – F_{DL_high}	F_{DL_low} – F_{DL_high}		
CA_n78-n258	n78	3300 MHz – 3800 MHz	TDD				
	n258	24250 MHz – 27500 MHz	TDD				

8.6.1.2 Channel bandwidths per operating band for CA

Table 8.6.2-1: Supported bandwidths per CA band combination of band n78+n258

NR CA configuration	Uplink CA configuration	NR Band	SCS (kH z)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	200 MHz	400 MHz	Bandwidth combination set		
CA_n78A-n258A	CA_n78A-n258A	n78	15	Yes	Yes	Yes			Yes	Yes								0		
			30	Yes	Yes	Yes			Yes											
			60	Yes	Yes	Yes			Yes											
		n258	60							Yes					Yes	Yes		0		
			120							Yes				Yes	Yes	Yes	Yes			
CA_n78A-n258G	CA_n78A-n258A CA_n78A-n258G	n78	15	Yes	Yes	Yes			Yes	Yes								0		
			30	Yes	Yes	Yes			Yes											
			60	Yes	Yes	Yes			Yes											
		n258	See CA_n258G Bandwidth Combination Set 0 in Table 5.5A.1-1 from 38.101-2															0		
			15	Yes	Yes	Yes			Yes	Yes										
CA_n78A-n258H	CA_n78A-n258A CA_n78A-n258G CA_n78A-n258H	n78	30	Yes	Yes	Yes			Yes			0								
			60	Yes	Yes	Yes			Yes											
		n258	See CA_n258H Bandwidth Combination Set 0 in Table 5.5A.1-1 from 38.101-2																0	
			15	Yes	Yes	Yes			Yes	Yes										
CA_n78A-n258I	CA_n78A-n258A CA_n78A-n258G CA_n78A-n258H CA_n78A-n258I	n78	30	Yes	Yes	Yes			Yes			0								
			60	Yes	Yes	Yes			Yes											
		n258	See CA_n258I Bandwidth Combination Set 0 in Table 5.5A.1-1 from 38.101-2																0	
			15	Yes	Yes	Yes			Yes	Yes										
CA_n78A-n258J	CA_n78A-n258A CA_n78A-n258G CA_n78A-n258H CA_n78A-n258I CA_n78A-n258J	n78	30	Yes	Yes	Yes			Yes			0								
			60	Yes	Yes	Yes			Yes											
		n258	See CA_n258J Bandwidth Combination Set 0 in Table 5.5A.1-1 from 38.101-2																0	
			15	Yes	Yes	Yes			Yes	Yes										
CA_n78A-n258K	CA_n78A-n258A CA_n78A-n258G	n78	30	Yes	Yes	Yes			Yes			0								
			60	Yes	Yes	Yes			Yes											

8.6.1.3 Co-existence studies

Table 8.6.3-1 gives the UL 2nd, 3rd, 4th, 5th, 6th, 7th harmonic for CA_n78A-n258A. The 7th harmonic produced by UL band n78 may fall into Band n258 DL.

Table 8.6.1.3-1: Band n78 and Band n258 UL harmonics products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	3300	3800	24250	27500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2*fy_low	2*fy_high
2nd harmonics frequency limits (MHz)	6600	7600	48500	55000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3*fy_low	3*fy_high
3rd harmonics frequency limits (MHz)	9900	11400	72750	82500
4th harmonics frequency limits	4*fx_low	4*fx_high	4*fy_low	4*fy_high
4th harmonics frequency limits (MHz)	13200	15200	97000	110000
5th harmonics frequency limits	5*fx_low	5*fx_high	5*fy_low	5*fy_high
5th harmonics frequency limits (MHz)	16500	19000	121250	137500
6th harmonics frequency limits	6*fx_low	6*fx_high	6*fy_low	6*fy_high
6th harmonics frequency limits (MHz)	19800	22800	145500	165000
7th harmonics frequency limits	7*fx_low	7*fx_high	7*fy_low	7*fy_high
7th harmonics frequency limits (MHz)	23100	26600	169750	192500

8.6.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n78A-n258A, the $T_{IB,c}$ and R_{IB} values are given in the tables below.

Table 8.6.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n78-n258	n78	0
	n258	0

Table 8.6.4-2: ΔR_{IB}

Inter-band CA Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
CA_n78-n258	n78	0
	n258	0

8.6.1.5 REFSENS requirements

There is no specific REFSENS requirement.

8.6.2 Specific for 2 bands UL CA

8.6.2.1 UE co-existence studies

Table 8.6.2.1-1 lists Band n78 + Band n258 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 8.6.2.1-1: Band n78 and Band n258 UL IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
2nd order IMD products	$ fy_high - fx_low $	$ fy_low - fx_high $	$ fy_low + fx_low $	$ fy_high + fx_high $
IMD frequency limits (MHz)	24200	20450	27550	31300
3rd order IMD products	$ fy_high - 2*fx_low $	$ fy_low - 2*fx_high $	$ 2*fy_low - fx_high $	$ 2*fy_high - fx_low $
IMD frequency limits (MHz)	20900	16650	44700	51700
3rd order IMD products	$ 2*fx_low + fy_low $	$ 2*fx_high + fy_high $	$ 2*fy_low + fx_low $	$ 2*fy_high + fx_high $
IMD frequency limits (MHz)	30850	35100	51800	58800
Two-tone 4th order IMD products	$ 2*fx_low - 2*fy_high $	$ 2*fx_high - 2*fy_low $	$ 2*fx_low + 2*fy_low $	$ 2*fx_high + 2*fy_high $
IMD frequency limits (MHz)	48400	40900	55100	62600
Two-tone 4th order IMD products	$ 3*fx_low - 1*fy_high $	$ 3*fx_high - 1*fy_low $	$ 3*fy_low - 1*fx_high $	$ 3*fy_high - 1*fx_low $
IMD frequency limits (MHz)	17600	12850	68950	79200
Two-tone 4th order IMD products	$ 3*fx_low + 1*fy_low $	$ 3*fx_high + 1*fy_high $	$ 3*fy_low + 1*fx_low $	$ 3*fy_high + 1*fx_high $
IMD frequency limits (MHz)	34150	38900	76050	86300
Two-tone 5th order IMD products	$ fx_low - 4*fy_high $	$ fx_high - 4*fy_low $	$ fy_low - 4*fx_high $	$ fy_high - 4*fx_low $
IMD frequency limits (MHz)	106700	93200	9050	14300
Two-tone 5th order IMD products	$ fx_low + 4*fy_low $	$ fx_high + 4*fy_high $	$ fy_low + 4*fx_low $	$ fy_high + 4*fx_high $
IMD frequency limits (MHz)	100300	113800	37450	42700
Two-tone 5th order IMD products	$ 2*fx_low - 3*fy_high $	$ 2*fx_high - 3*fy_low $	$ 2*fy_low - 3*fx_high $	$ 2*fy_high - 3*fx_low $
IMD frequency limits (MHz)	75900	65150	37100	45100
Two-tone 5th order IMD products	$ 2*fx_low + 3*fy_low $	$ 2*fx_high + 3*fy_high $	$ 2*fy_low + 3*fx_low $	$ 2*fy_high + 3*fx_high $
IMD frequency limits (MHz)	79350	90100	58400	66400

Based on Table 8.6.2.1-1 there are no IMD issues affecting own Rx frequencies.

8.6.2.2 REFSENS requirements

Based on the co-existence studies in 8.6.2.1, there is no need to define MSD for CA_n78-n258.

8.7 CA_n79-n258

8.7.1 Common for 1 band UL and 2 bands UL CA

8.7.1.1 Operating bands for CA

Table 8.7.1-1: CA band combination of band n79 + n258

NR CA Band Combination	NR Band	Uplink (UL) band						Downlink (DL) band						Duplex mode	
		BS receive / UE transmit						BS transmit / UE receive							
		$F_{UL_low} - F_{UL_high}$						$F_{DL_low} - F_{DL_high}$							
CA_n79-n258	n79	4400 MHz – 5000 MHz						4400 MHz – 5000 MHz						TDD	
	n258	24250 MHz – 27500 MHz						24250 MHz – 27500 MHz						TDD	

8.7.1.2 Channel bandwidths per operating band for CA

Table 8.7.2-1: Supported bandwidths per CA band combination of band n79+n258

NR CA configuration	Uplink CA configuration	NR Band	SCS (kH z)	5 M Hz	10 M Hz	15 M Hz	20 M Hz	40 M Hz	50 M Hz	60 M Hz	80 M Hz	90 M Hz	100 M Hz	200 M Hz	400 M Hz	Bandwidth combination set
CA_n79A-n258A	-	n79	15					Yes	Yes							0
			30					Yes	Yes	Yes	Yes		Yes			
			60					Yes	Yes	Yes	Yes		Yes			
	-	n258	60						Yes				Yes	Yes		
			120						Yes				Yes	Yes	Yes	

8.7.1.3 Co-existence studies

Table 8.7.3-1 gives the UL 2nd, 3rd, 4th, 5th, 6th, 7th harmonic for CA_n79A-n258A. The 5th and 6th harmonic produced by UL band n79 may fall into Band n258 DL.

Table 8.7.1.3-1: Band n79 and Band n258 UL harmonics products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	4400	5000	24250	27500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2*fy_low	2*fy_high
2nd harmonics frequency limits (MHz)	8800	10000	48500	55000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3*fy_low	3*fy_high
3rd harmonics frequency limits (MHz)	13200	15000	72750	82500
4th harmonics frequency limits	4*fx_low	4*fx_high	4*fy_low	4*fy_high
4th harmonics frequency limits (MHz)	17600	20000	97000	110000
5th harmonics frequency limits	5*fx_low	5*fx_high	5*fy_low	5*fy_high

5th harmonics frequency limits (MHz)	22000	25000	121250	137500
6th harmonics frequency limits	6*fx_low	6*fx_high	6*fy_low	6*fy_high
6th harmonics frequency limits (MHz)	26400	30000	145500	165000
7th harmonics frequency limits	7*fx_low	7*fx_high	7*fy_low	7*fy_high
7th harmonics frequency limits (MHz)	30800	35000	169750	192500

8.7.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n79A-n258A, the $T_{IB,c}$ and R_{IB} values are given in the tables below.

Table 8.7.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n79-n258	n79	0
	n258	0

Table 8.7.4-2: ΔR_{IB}

Inter-band CA Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
CA_n79-n258	n79	0
	n258	0

8.7.1.5 REFSENS requirements

There is no specific REFSENS requirement.

8.8 CA_n1-n257

8.8.1 Common for 1 band UL and 2 bands UL CA

8.8.1.1 Operating bands for CA

Table 8.8.1.1-1: CA band combination of band n1+n257

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode		
	BS receive / UE transmit		BS transmit / UE receive				
	$F_{UL_low} - F_{UL_high}$		$F_{DL_low} - F_{DL_high}$				
n1	1920MHz	–	1980MHz	2110MHz	–	2170MHz	FDD
n257	26500MHz	–	29500MHz	26500MHz	–	29500MHz	TDD

8.8.1.2 Channel bandwidths per operating band for CA

Table 8.8.1.2-1: Supported bandwidths per CA band combination of band n1+n257

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	200 MHz	400 MHz	Band width combination set
CA_n71A-n260A	-	n1	15	Yes	Yes	Yes	Yes								0
			30		Yes	Yes	Yes								
			60		Yes	Yes	Yes								
		n257	60						Yes			Yes	Yes		0
			120						Yes			Yes	Yes	Yes	
		n1	15	Yes	Yes	Yes	Yes								0
			30		Yes	Yes	Yes								
			60		Yes	Yes	Yes								
		n257	60						Yes			Yes	Yes		0
			120						Yes			Yes	Yes	Yes	

8.8.1.3 UE co-existence studies

Table 8.8.1.3-1 lists up to 7th harmonics for CA_n1-n257.

Table 8.8.1.3-1: Impact of UL/DL Harmonic

			2 nd Harmonic		3 rd Harmonic		4 th Harmonic		5 th Harmonic		6 th Harmonic		7 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n1	1920	1980	3840	3960	5760	5940	7680	7920	9600	9900	11520	11880	13440	13860
n257	26500	29500	53000	59000	79500	88500	106k	118k	132.5k	147.5k	159k	177k	185.5k	206.5k

8.8.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n1-n257, the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 8.8.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n1-n257	n1	0
	n257	0

Table 8.8.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,C}$ [dB]
CA_n1-n257	n1	0
	n257	0

8.8.1.5 REFSENS requirements

There is no need for additional REFSENS requirements.

8.8.2 Specific for 2 bands UL CA

8.8.2.1 UE co-existence studies

Table 8.8.2.1-1 lists Band n1 +Band n257 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 8.8.2.1-1: Band n1 and Band n257 2UL bands IMD products

UE UL carriers	Fx_low	Fx_high	Fy_low	Fy_high
UL frequency (MHz)	1920	1980	26500	29500
2nd order IMD products	$ f_y_low - f_x_high $	$ f_y_high - f_x_low $	$ f_y_low + f_x_low $	$ f_y_high + f_x_high $
IMD frequency limits (MHz)	24520	27580	28420	31480
Two-tone 3rd order IMD products	$ 2*f_x_low - f_y_high $	$ 2*f_x_high - f_y_low $	$ 2*f_y_low - f_x_high $	$ 2*f_y_high - f_x_low $
IMD frequency limits (MHz)	25660	22540	51020	57080
Two-tone 3rd order IMD products	$ 2*f_x_low + f_y_low $	$ 2*f_x_high + f_y_high $	$ 2*f_y_low + f_x_low $	$ 2*f_y_high + f_x_high $
IMD frequency limits (MHz)	30340	33460	54920	60980
Two-tone 4th order IMD products	$ 3*f_x_low - 1*f_y_high $	$ 3*f_x_high - 1*f_y_low $	$ 3*f_y_low - 1*f_x_high $	$ 3*f_y_high - 1*f_x_low $
IMD frequency limits (MHz)	-23740	-20560	77520	86580
Two-tone 4th order IMD products	$ 2*f_x_low - 2*f_y_high $	$ 2*f_x_high - 2*f_y_low $		
IMD frequency limits (MHz)	55160	49040		
Two-tone 4th order IMD products	$ 3*f_x_low + 1*f_y_low $	$ 3*f_x_high + 1*f_y_high $	$ 3*f_y_low + 1*f_x_low $	$ 3*f_y_high + 1*f_x_high $
IMD frequency limits (MHz)	32260	35440	81420	90480

Two-tone 4th order IMD products	$ 2*fx_{low} + 2*fy_{low} $	$ 2*fx_{high} + 2*fy_{high} $		
IMD frequency limits (MHz)	56840	62960		
Two-tone 5th order IMD products	$ fx_{low} - 4*fy_{high} $	$ fx_{high} - 4*fy_{low} $	$ fy_{low} - 4*fx_{high} $	$ fy_{high} - 4*fx_{low} $
IMD frequency limits (MHz)	116080	104020	18580	21820
Two-tone 5th order IMD products	$ 2*fx_{low} - 3*fy_{high} $	$ 2*fx_{high} - 3*fy_{low} $	$ 2*fy_{low} - 3*fx_{high} $	$ 2*fy_{high} - 3*fx_{low} $
IMD frequency limits (MHz)	84660	75540	47060	53240
Two-tone 5th order IMD products	$ fx_{low} + 4*fy_{low} $	$ fx_{high} + 4*fy_{high} $	$ fy_{low} + 4*fx_{low} $	$ fy_{high} + 4*fx_{high} $
IMD frequency limits (MHz)	107920	119980	34180	37420
Two-tone 5th order IMD products	$ 2*fx_{low} + 3*fy_{low} $	$ 2*fx_{high} + 3*fy_{high} $	$ 2*fy_{low} + 3*fx_{low} $	$ 2*fy_{high} + 3*fx_{high} $
IMD frequency limits (MHz)	83340	92460	58760	64940

Table 8.8.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 8.8.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n1A-n257A	E-UTRA Band 1, 3, 5, 7, 8, 11, 18, 19, 20, 21, 26, 28, 34, 40, 41, 65	F_{DL_low}	-	F_{DL_high}	-50	1
	Frequency range	1880	-	1895	-40	1
	Frequency range	1895	-	1915	-15.5	5
	Frequency range	1915	-	1920	+1.6	5

8.8.2.2 REFSENS requirements

There is no need for additional REFSENS requirements.

8.9 CA_n78-n257

8.9.1 Common for 1 band UL and 2 bands UL CA

8.9.1.1 Operating bands for CA

Table 8.9.1.1-1: CA band combination of band n78+n257

NR Band	Uplink (UL) band				Downlink (DL) band				Duplex mode					
	BS receive / UE transmit		BS transmit / UE receive											
	$F_{UL_low} - F_{UL_high}$		$F_{DL_low} - F_{DL_high}$											
n78	3300 MHz – 3800 MHz		3300 MHz – 3800 MHz		3300 MHz – 3800 MHz		3300 MHz – 3800 MHz		TDD					
n257	26500 MHz – 29500 MHz		26500 MHz – 29500 MHz		26500 MHz – 29500 MHz		26500 MHz – 29500 MHz		TDD					

8.9.1.2 Channel bandwidths per operating band for CA

Table 8.9.1.2-1: Supported bandwidths per CA band combination of band n78+n257

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	200 MHz	400 MHz	Band width combination set		
CA_n78A-n257G	CA_n78A-n257A	n78	15		Yes	Yes	Yes	Yes	Yes						0		
			30		Yes												
			60		Yes												
	CA_n78A-n257H	n257	See CA_n257G in Table 5.5A.1-1 in TS 38.101-2														
			15		Yes	Yes	Yes	Yes							0		
			30		Yes												
CA_n78A-n257I	CA_n78A-n257A	n78	60		Yes			0									
			See CA_n257H in Table 5.5A.1-1 in TS 38.101-2														
			15		Yes	Yes	Yes	Yes									
		n257	30		Yes			0									
			60		Yes												
			See CA_n257I in Table 5.5A.1-1 in TS 38.101-2														
CA_n78A-n257J	CA_n78A-n257A	n78	15		Yes	Yes	Yes	Yes	Yes						0		
			30		Yes												
			60		Yes												
	n257	See CA_n257J in Table 5.5A.1-1 in TS 38.101-2															
		15		Yes	Yes	Yes	Yes	Yes						0			
		30		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes						
CA_n78A-n257K	CA_n78A-n257A	n78	60		Yes			0									
			See CA_n257K in Table 5.5A.1-1 in TS 38.101-2														
			15		Yes	Yes	Yes	Yes	Yes								
		n257	30		Yes			0									
			60		Yes												
			See CA_n257K in Table 5.5A.1-1 in TS 38.101-2														
CA_n78A-n257L	CA_n78A-n257A	n78	15		Yes	Yes	Yes	Yes	Yes						0		
			30		Yes												
			60		Yes												
	n257	See CA_n257L in Table 5.5A.1-1 in TS 38.101-2															
		15		Yes	Yes	Yes	Yes	Yes						0			
		30		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes						
CA_n78A-n257M	CA_n78A-n257A	n78	60		Yes			0									
			See CA_n257M in Table 5.5A.1-1 in TS 38.101-2														
			15		Yes	Yes	Yes	Yes	Yes								
		n257	30		Yes			0									
			60		Yes												
			See CA_n257M in Table 5.5A.1-1 in TS 38.101-2														
	n257	See CA_n257M in Table 5.5A.1-1 in TS 38.101-2															
		30		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			0			
		60		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes						

8.9.1.3 UE co-existence studies

The studies for 1 band UL for the CA band combination of band n78 + n257 have been already completed and captured into TR 37.865-01-01. It is expected that only 7th order harmonic of Band n78 UL may fall into Band n257 DL according to TR 37.865-01-01.

8.9.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n78-n257, the $T_{IB,c}$ and $R_{IB,c}$ values are already specified in TR37.865-01-01.

8.9.1.5 REFSENS requirements

The studies for 1 band UL for the CA band combination of band n78 + n257 have been already completed and captured into TR 37.865-01-01. There are no need for additional REFSENS requirements for 1 band UL according to TR 37.865-01-01.

8.9.2 Specific for 2 bands UL CA

8.9.2.1 UE co-existence studies

The studies for 2 band UL for the CA band combination of band n78 + n257 have been already completed and captured into TR 37.866-00-02.

8.9.2.2 REFSENS requirements

The studies for 2 band UL for the CA band combination of band n78 + n257 have been already completed and captured into TR 37.866-00-02. There are no need for additional REFSENS requirements for 2 band UL according to TR 37.866-00-02.

8.10 CA_n41-n260

8.10.1 Common for 1 band UL and 2 bands UL CA

8.10.1.1 Operating bands for CA

Table 8.10.1.1-1: CA band combination of band nX+nY

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode		
	BS receive / UE transmit		BS transmit / UE receive				
	$F_{UL_low} - F_{UL_high}$		$F_{DL_low} - F_{DL_high}$				
n41	2496 MHz	–	2690 MHz	2496 MHz	–	2690 MHz	TDD
n260	37000 MHz	–	40000 MHz	37000 MHz	–	40000 MHz	

8.10.1.2 Channel bandwidths per operating band for CA

Table 8.10.1.2-1: Supported bandwidths per CA band combination of band nX+nY

CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	200 MHz	400 MHz	BW
n41A 60A	-	n41	15	Yes	Yes	Yes	Yes	Yes	Yes								
			30	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
			60	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
		n260	60							Yes				Yes	Yes		
			120							Yes				Yes	Yes	Yes	
	-	n41	15	Yes	Yes	Yes	Yes	Yes	Yes	Yes							
			30	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
			60	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
		n260	See CA_n260(2A) in Table 5.5A.2-1 of TS 38.101-2														

8.10.1.3 UE co-existence studies

Table 8.10.1.3-1 lists up to 7th harmonics for CA_n41A-n260A.

Table 8.10.1.3-1: Impact of UL/DL Harmonic

			2 nd Harmonic		3 rd Harmonic		4 th Harmonic		5 th Harmonic		6 th Harmonic		7 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n41	2496	2690	4992	5380	7488	8070	9984	10760	12480	13450	14976	16140	17472	18830
n260	37000	40000	74000	80000	111 k	120 k	148 k	160 k	185 k	200 k	222 k	240 k	259 k	280 k

8.10.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n41A-n260, the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 8.10.1.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
CA_n41-n260	n41	0
	n260	0

Table 8.10.1.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
CA_n41-n260	n41	0
	n260	0

8.10.1.5 REFSENS requirements

There is no need for additional REFSENS requirements.

8.11 CA_n25-n260

8.11.1 Common for 1 band UL and 2 bands UL CA

8.11.1.1 Operating bands for CA

Table 8.11.1.1-1: CA band combination of band nX+nY

NR Band	Uplink (UL) band			Downlink (DL) band			Duplex mode	
	BS receive / UE transmit			BS transmit / UE receive				
	$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$				
n25	1850 MHz – 1915 MHz			1930 MHz – 1995 MHz			FDD	
n260	37000 MHz – 40000 MHz			37000 MHz – 40000 MHz			TDD	

8.11.1.2 Channel bandwidths per operating band for CA

Table 8.11.1.2-1: Supported bandwidths per CA band combination of band nX+nY

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz z)	5 MHz	10 MHz	15 MHz	20 MHz	40 MHz	50 MHz	60 MHz	100 MHz	200 MHz	400 MHz	Band width combination set
CA_n25A-n260A	-	n25	15	Yes	Yes	Yes	Yes							0
			30		Yes	Yes								
			60		Yes	Yes								
		n260	60						Yes		Yes	Yes		0
			120						Yes		Yes	Yes	Yes	
CA_n25A-n260(2A)	-	n25	15	Yes	Yes	Yes	Yes							0
			30		Yes	Yes	Yes							
			60		Yes	Yes	Yes							
		n260	See CA_n260(2A) in Table 5.5A.2-1 of TS 38.101-2											

8.11.1.3 UE co-existence studies

Table 8.11.1.3-1 lists up to 7th harmonics for CA_n25A-n260A.

Table 8.11.1.3-1: Impact of UL/DL Harmonic

			2 nd Harmonic	3 rd Harmonic	4 th Harmonic	5 th Harmonic	6 th Harmonic	7 th Harmonic
Band	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n25	1850	1915	3700	3830	5550	5745	7400	7660
n260	37000	40000	74000	80000	111 k	120 k	148 k	160 k

8.11.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n25A-n260, the $T_{IB,c}$ and $R_{IB,c}$ values are given in the tables below.

Table 8.11.1.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
CA_n25-n260	n25	0
	n260	0

Table 8.11.1.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
CA_n25-n260	n25	0
	n260	0

8.11.1.5 REFSENS requirements

There is no need for additional REFSENS requirements.

8.12 CA_n77-n257

8.12.1 Common for 1 band UL and 2 bands UL CA

8.12.1.1 Operating bands for CA

Table 8.12.1.1-1: CA band combination of band n77+n257

NR Band	Uplink (UL) band	Downlink (DL) band	Duplex mode
	BS receive / UE transmit	BS transmit / UE receive	
	$F_{UL_low} - F_{UL_high}$	$F_{DL_low} - F_{DL_high}$	
n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	TDD
n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD

8.12.1.2 Channel bandwidths per operating band for CA

Table 8.12.1.2-1: Supported bandwidths per CA band combination of band n77+n257

NR CA configuration / Bandwidth combination set																		
NR CA configuration	NR Uplink CA configuration	NR Band	SC S (kH z)	5 MH z	10 MH z	15 MH z	20 MH z	25 MH z	30 MH z	40 MH z	50 MH z	60 MH z	80 MH z	90 MH z	100 MH z	200 MH z	400 MH z	Bandwid th combina tion set
CA_n77A-n257G	CA_n77A-n257A CA_n77A-n257G	n77	15		Yes	Yes	Yes			Yes	Yes							0
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes		Yes			
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes		Yes			
	n257		See CA_n257G in Table 5.5A1-2 in TS 38.101-2															
CA_n77A-n257H	CA_n77A-n257A CA_n77A-n257G CA_n77A-n257H	n77	15		Yes	Yes	Yes			Yes	Yes							0
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes		Yes			
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes		Yes			
	n257		See CA_n257H in Table 5.5A1-2 in TS 38.101-2															
CA_n77A-n257I	CA_n77A-n257A CA_n77A-n257G CA_n77A-n257H	n77	15		Yes	Yes	Yes			Yes	Yes							0
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes		Yes			
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes		Yes			
	n257		See CA_n257I in Table 5.5A1-2 in TS 38.101-2															
CA_n77(2A)-n257A	CA_n77A-n257A	n77(2A)	See CA_n77(2A) in Table 5.5A.2-1 in TS 38.101-1															0
		n257	60								Yes				Yes	Yes		
			120								Yes				Yes	Yes	Yes	
CA_n77(2A)-n257D	CA_n77A-n257A, CA_n77A-n257D	n77(2A)	See CA_n77(2A) in Table 5.5A.2-1 in TS 38.101-1															0
		n257	See CA_n257D in Table 5.5A.1-2 in TS 38.101-2															
CA_n77(2A)-n257G	CA_n77A-n257A, CA_n77A-n257G	n77(2A)	See CA_n77(2A) in Table 5.5A.2-1 in TS 38.101-1															0
		n257	See CA_n257G in Table 5.5A.1-2 in TS 38.101-2															
CA_n77(2A)-n257H	CA_n77A-n257A, CA_n77A-n257G, CA_n77A-n257H	n77(2A)	See CA_n77(2A) in Table 5.5A.2-1 in TS 38.101-1															0
		n257	See CA_n257H in Table 5.5A.1-2 in TS 38.101-2															
CA_n77(2A)-n257I	CA_n77A-n257A, CA_n77A-n257G, CA_n77A-n257H, CA_n77A-n257I	n77(2A)	See CA_n77(2A) in Table 5.5A.2-1 in TS 38.101-1															0
		n257	See CA_n257I in Table 5.5A.1-2 in TS 38.101-2															

8.12.1.3 Co-existence studies

Table 8.12.1.3-1 gives the UL 2nd, 3rd, 4th, 5th, 6th, 7th harmonic for CA_n77A-n257A.

Table 8.12.1.3-1: Band n77 and Band n258 UL harmonics products

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency(MHz)	3300	4200	26500	29500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2*fy_low	2*fy_high
2nd harmonics frequency limits(MHz)	6600	8400	53000	59000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3*fy_low	3*fy_high
3rd harmonics frequency limits(MHz)	9900	12600	79500	88500
4th harmonics frequency limits	4*fx_low	4*fx_high	4*fy_low	4*fy_high
4th harmonics frequency limits(MHz)	13200	16800	106000	118000
5th harmonics frequency limits	5*fx_low	5*fx_high	5*fy_low	5*fy_high
5th harmonics frequency limits(MHz)	16500	21000	132500	147500
6th harmonics frequency limits	6*fx_low	6*fx_high	6*fy_low	6*fy_high
6th harmonics frequency limits(MHz)	19800	25200	159000	177000
7th harmonics frequency limits	7*fx_low	7*fx_high	7*fy_low	7*fy_high
7th harmonics frequency limits(MHz)	23100	29400	185500	206500

8.12.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n77-n257, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are given in the tables below.

Table 6.4.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n77-n257	n77	0
	n257	0

Table 6.4.4-2: ΔR_{IB}

Inter-band CA Configuration	NR Band	ΔR_{IB} [dB]
CA_n77-n257	n77	0
	n257	0

8.12.1.5 REFSENS requirements

There are no specific REFSENS requirements for 1 band UL.

8.12.2 Specific for 2 bands UL CA

8.12.2.1 UE co-existence studies

Table 8.12.2-1 lists Band n77+Band n257 2UL CA 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis..

Table 8.12.2.1-1: Band n77 and Band n257 UL harmonics products

UE UL carriers	fx_low	fx_high	<bfy_low< b=""></bfy_low<>	fy_high
UL frequency (MHz)	3300	4200	26500	29500
2 nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2 nd harmonics frequency limits (MHz)	6600–8400		53000–59000	
3 rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3 rd harmonics frequency limits (MHz)	9900–12600		79500–88500	
2 nd order IMD products	fy_low – fx_high	fy_high – fx_low	fy_low + fx_low	fy_high + fx_high
IMD frequency limits (MHz)	22300–26200		29800–33700	
Two-tone 3 rd order IMD products	2*fx_low – fy_high	2*fx_high – fy_low	2*fy_low – fx_high	2*fy_high – fx_low
IMD frequency limits (MHz)	18100–22900		48800–54800	
Two-tone 3 rd order IMD products	2*fx_low + fy_low	2*fx_high + fy_high	2*fy_low + fx_low	2*fy_high + fx_high
IMD frequency limits (MHz)	33100–37900		56300–63200	
Two-tone 3 rd order IMD products	(fx_low – max BW fy)	(fx_high + max BW fy)	(fy_low – max BW fx)	(fy_high + max BW fx)
IMD frequency limits (MHz)	2900–4600		26400–29600	
Two-tone 4 th order IMD products	3*fx_low – 1* fy_high	3*fx_high – 1*fy_low	3*fy_low – 1*fx_high	3*fy_high – 1*fx_low
IMD frequency limits (MHz)	13900–19600		75300–85200	
Two-tone 4 th order IMD products	2*fx_low – 2* fy_high	2*fx_high – 2* fy_low		
IMD frequency limits (MHz)	44600–81900			
Two-tone 4 th order IMD products	3*fx_low + 1* fy_low	3*fx_high + 1*fy_high	3*fy_low + 1*fx_low	3*fy_high + 1*fx_high
IMD frequency limits (MHz)	36400–41200		82800–92700	
Two-tone 4 th order IMD products	2*fx_low + 2* fy_low	2*fx_high + 2* fy_high		
IMD frequency limits (MHz)	59600–67400			
Two-tone 5 th order IMD products	fx_low – 4*fy_high	fx_high – 4*fy_low	fy_low – 4*fx_high	fy_high – 4*fx_low
IMD frequency limits (MHz)	101800–114700		9700–16300	
Two-tone 5 th order IMD products	2*fx_low - 3*fy_high	2*fx_high - 3*fy_low	2*fy_low - 3*fx_high	2*fy_high - 3*fx_low
IMD frequency limits (MHz)	71100–81900		40400–49100	
Two-tone 5 th order IMD products	fx_low + 4*fy_low	fx_high + 4*fy_high	fy_low + 4*fx_low	fy_high + 4*fx_high
IMD frequency limits (MHz)	109300–122200		39700–46300	
Two-tone 5 th order IMD products	2*fx_low + 3*fy_low	2*fx_high + 3*fy_high	2*fy_low + 3*fx_low	2*fy_high + 3*fx_high

IMD frequency limits (MHz)	86100– 96900	62900– 71600
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Based on Table 8.12.2.1-1, there are no harmonic or IMD issues affecting own Rx frequencies of either band n77 or n257.

Table 8.12.2.1-3 lists the protected bands required for the 2UL CA configuration.

Table 8.12.2.1-3: Protected bands for the 2UL CA configuration

Uplink NR CA configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n77A-n257A	E-UTRA Band 1, 3, 5, 7, 8, 11, 18, 19, 21, 26, 28, 34, 39, 40, 41, 65	F_{DL_low}	-	F_{DL_high}	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3
						PHS

8.12.2.2 REFSENS requirements

The studies for 2 band UL for the CA band combination of band n77 + n257 have been already completed and captured into TR 37.866-00-02. There are no need for additional REFSENS requirements for 2 band UL according to TR 37.866-00-02.

8.13 CA_n3-n257

8.13.1 Common for 1 band UL and 2 bands UL CA

8.13.1.1 Operating bands for CA

Table 8.13.1.1-1: CA band combination of band n3+n257

NR CA Band	NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
		BS receive / UE transmit		BS transmit / UE receive			
		$F_{UL_low} - F_{UL_high}$	$F_{DL_low} - F_{DL_high}$	$F_{DL_low} - F_{DL_high}$	$F_{DL_low} - F_{DL_high}$		
CA_n3-n257	n3	1710 MHz – 1785 MHz		1805 MHz – 1880 MHz		FDD	
	n257	26500 MHz – 29500 MHz		26500 MHz – 29500 MHz		TDD	

8.13.1.2 Channel bandwidths per operating band for CA

Table 8.13.1.2-1: Supported bandwidths per CA band combination of band n3+n257

NR CA configuration / Bandwidth combination set																					
NR CA configuration	NR Uplink CA configuration	NR Band	SC S (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	200 MHz	400 MHz	Maximum Aggregated bandwidth [MHz]	Bandwidth combination set		
CA_n3A-n257A	CA_n3A-n257A	n3	15	Yes	Yes	Yes	Yes	Yes	Yes									430	0		
			30		Yes	Yes	Yes	Yes	Yes												
			60		Yes	Yes	Yes	Yes	Yes												
		n257	60								Yes					Yes	Yes	430	0		
			120								Yes					Yes	Yes				
CA_n3A-n257D	CA_n3A-n257A	n3	15	Yes	Yes	Yes	Yes	Yes	Yes									430	0		
			30		Yes	Yes	Yes	Yes	Yes												
	CA_n3A-n257D		60		Yes	Yes	Yes	Yes	Yes												
	n257	See CA_n257D in Table 5.5A.1-2 in TS 38.101-2																			
CA_n3A-n257G	CA_n3A-n257A	n3	15	Yes	Yes	Yes	Yes	Yes	Yes									230	0		
			30		Yes	Yes	Yes	Yes	Yes												
			60		Yes	Yes	Yes	Yes	Yes												
	CA_n3A-n257G	n257	See CA_n257G in Table 5.5A.1-2 in TS 38.101-2																		
		n3	15	Yes	Yes	Yes	Yes	Yes	Yes									330	0		
CA_n3A-n257H	CA_n3A-n257A	n3	30		Yes	Yes	Yes	Yes	Yes												
			60		Yes	Yes	Yes	Yes	Yes												
			n257	See CA_n257H in Table 5.5A.1-2 in TS 38.101-2																	
	CA_n3A-n257G	n3	15	Yes	Yes	Yes	Yes	Yes	Yes									430	0		
			30		Yes	Yes	Yes	Yes	Yes												
CA_n3A-n257I	CA_n3A-n257A	n3	60		Yes	Yes	Yes	Yes	Yes									430	0		
			n257	See CA_n257I in Table 5.5A.1-2 in TS 38.101-2																	
			15	Yes	Yes	Yes	Yes	Yes	Yes												
			30		Yes	Yes	Yes	Yes	Yes												
			60		Yes	Yes	Yes	Yes	Yes												

8.13.1.3 Co-existence studies

Table 8.13.1.3-1 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n3-n257.

Table 8.13.1.3-1: Impact of UL/DL Harmonic

UE UL carriers	fx_low	fx_high	fy_high	
UL frequency (MHz)	1710	1785	26500	29500
2 nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2 nd harmonics frequency limits (MHz)	3420	3570	53000	59000

3 rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3 rd harmonics frequency limits (MHz)	5130	5355	79500	88500
4 th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4 th harmonics frequency limits (MHz)	6840	7140	106000	118000
5 th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5 th harmonics frequency limits (MHz)	8550	8925	132500	147500
6 th harmonics frequency limits	6*fx_low	6*fx_high	6* fy_low	6* fy_high
6 th harmonics frequency limits (MHz)	10260	10710	159000	177000
7 th harmonics frequency limits	7*fx_low	7*fx_high	7* fy_low	7* fy_high
7 th harmonics frequency limits (MHz)	11970	12495	185500	206500

8.13.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n3-n257, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values for UEs not supporting simultaneous Rx/Tx are given in the tables below.

Table 8.13.1.4-1: $\Delta T_{IB,c}$

Inter-band EN-DC configuration	NR Band	$\Delta T_{IB,c}$ (dB)
CA_n3-n257	n3	0
	n257	0

Table 8.13.1.4-2: $\Delta R_{IB,c}$

Inter-band EN-DC configuration	NR Band	$\Delta R_{IB,c}$ (dB)
CA_n3-n257	n3	0
	n257	0

8.13.1.5 REFSEN requirements

As mentioned in section 8.13.1.3, REFSENSE due to harmonic is not expected.

8.13.2 Specific for 2 bands UL CA

8.13.2.1 UE co-existence studies

Table 8.13.2.1-1 lists Band n3 + Band n257 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 8.13.2.1-1: Band n3 and Band n257 UL IMD products

UE UL carriers	Fx_low	Fx_high	Fy_low	Fy_high
UL frequency (MHz)	1710	1785	26500	29500
2nd order IMD products	$ fy_{low} - fx_{high} $	$ fy_{high} - fx_{low} $	$ fy_{low} + fx_{low} $	$ fy_{high} + fx_{high} $
IMD frequency limits (MHz)	24715	27790	28210	31285
Two-tone 3rd order IMD products	$ 2*fx_{low} - fy_{high} $	$ 2*fx_{high} - fy_{low} $	$ 2*fy_{low} - fx_{high} $	$ 2*fy_{high} - fx_{low} $
IMD frequency limits (MHz)	26080	22930	51215	57290
Two-tone 3rd order IMD products	$ 2*fx_{low} + fy_{low} $	$ 2*fx_{high} + fy_{high} $	$ 2*fy_{low} + fx_{low} $	$ 2*fy_{high} + fx_{high} $
IMD frequency limits (MHz)	29920	33070	54710	60785
Two-tone 4th order IMD products	$ 3*fx_{low} - 1*fy_{high} $	$ 3*fx_{high} - 1*fy_{low} $	$ 3*fy_{low} - 1*fx_{high} $	$ 3*fy_{high} - 1*fx_{low} $
IMD frequency limits (MHz)	24370	21145	77715	86790
Two-tone 4th order IMD products	$ 2*fx_{low} - 2*fy_{high} $	$ 2*fx_{high} - 2*fy_{low} $		
IMD frequency limits (MHz)	49430	55580		
Two-tone 4th order IMD products	$ 3*fx_{low} + 1*fy_{low} $	$ 3*fx_{high} + 1*fy_{high} $	$ 3*fy_{low} + 1*fx_{low} $	$ 3*fy_{high} + 1*fx_{high} $
IMD frequency limits (MHz)	31630	34855	81210	90285
Two-tone 4th order IMD products	$ 2*fx_{low} + 2*fy_{low} $	$ 2*fx_{high} + 2*fy_{high} $		
IMD frequency limits (MHz)	56420	62570		
Two-tone 5th order IMD products	$ fx_{low} - 4*fy_{high} $	$ fx_{high} - 4*fy_{low} $	$ fy_{low} - 4*fx_{high} $	$ fy_{high} - 4*fx_{low} $
IMD frequency limits (MHz)	116290	104215	19360	22660
Two-tone 5th order IMD products	$ 2*fx_{low} - 3*fy_{high} $	$ 2*fx_{high} - 3*fy_{low} $	$ 2*fy_{low} - 3*fx_{high} $	$ 2*fy_{high} - 3*fx_{low} $
IMD frequency limits (MHz)	85080	75930	47645	53870
Two-tone 5th order IMD products	$ fx_{low} + 4*fy_{low} $	$ fx_{high} + 4*fy_{high} $	$ fy_{low} + 4*fx_{low} $	$ fy_{high} + 4*fx_{high} $
IMD frequency limits (MHz)	107710	119785	33340	36640
Two-tone 5th order IMD products	$ 2*fx_{low} + 3*fy_{low} $	$ 2*fx_{high} + 3*fy_{high} $	$ 2*fy_{low} + 3*fx_{low} $	$ 2*fy_{high} + 3*fx_{high} $
IMD frequency limits (MHz)	82920	92070	58130	64355

Based on Table 8.13.2.1-1, there are no IMD issues affecting own Rx frequencies of either band n3 or n257.

Table 8.13.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 8.13.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n3-n257	E-UTRA Band 1, 3, 5, 7, 8, 11, 18, 19, 20, 21, 26, 28, 34, 39, 40, 41, 65	F_{DL_low}	-	F_{DL_high}	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3
NOTE 1: Applicable when co-existence with PHS system operating in 1884.5 - 1915.7 MHz						

8.13.2.2 REFSENS requirements

According to the co-existence analysis in 8.13.2.1 there is no need for additional REFSENS requirements for the 2DL/2UL configuration of CA_n3A-n257A.

8.14 CA_n28-n257

8.14.1 Common for 1 band UL and 2 bands UL CA

8.14.1.1 Operating bands for CA

Table 8.14.1.1-1: CA band combination of band n28+n257

NR CA Band	NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
		BS receive / UE transmit		BS transmit / UE receive			
		$F_{UL_low} - F_{UL_high}$	$F_{DL_low} - F_{DL_high}$	$F_{DL_low} - F_{DL_high}$	$F_{DL_low} - F_{DL_high}$		
CA_n28-n257	n28	703 MHz – 748 MHz	758 MHz – 803 MHz	758 MHz – 803 MHz	758 MHz – 803 MHz	FDD	
	n257	26500 MHz – 29500 MHz	TDD				

8.14.1.2 Channel bandwidths per operating band for CA

Table 8.14.1.2-1: Supported bandwidths per CA band combination of band n28+n257

NR CA configuration / Bandwidth combination set

NR CA configuration	NR Uplink CA configuration	NR Band	SC S(k Hz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	200 MHz	400 MHz	Maximum Aggregated bandwidth [MHz]	Bandwidth combination set
CA_n28A-n257A	CA_n28A-n257A	n28	15	Yes	Yes	Yes	Yes											420	0
			30		Yes	Yes	Yes												
		n257	60								Yes					Yes	Yes	420	0
			120								Yes					Yes	Yes		
		n28	15	Yes	Yes	Yes	Yes											420	0
			30		Yes	Yes	Yes												
			n257	See CA_n257D in Table 5.5A.1-2 in TS 38.101-2															
CA_n28A-n257G	CA_n28A-n257A	n28	15	Yes	Yes	Yes	Yes											220	0
			30		Yes	Yes	Yes												
	CA_n28A-n257G	n257																220	0
				See CA_n257G in Table 5.5A.1-2 in TS 38.101-2															
CA_n28A-n257H	CA_n28A-n257A	n28	15	Yes	Yes	Yes	Yes											320	0
			30		Yes	Yes	Yes												
	CA_n28A-n257G	n257	See CA_n257H in Table 5.5A.1-2 in TS 38.101-2																
CA_n28A-n257I	CA_n28A-n257A	n28	15	Yes	Yes	Yes	Yes											420	0
	CA_n28A-n257G		30		Yes	Yes	Yes												
	CA_n28A-n257H	n257	See CA_n257I in Table 5.5A.1-2 in TS 38.101-2																
	CA_n28A-n257I	n257	See CA_n257I in Table 5.5A.1-2 in TS 38.101-2																

8.14.1.3 Co-existence studies

Table 8.14.1.3-1 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA_n28-n257.

Table 8.14.1.3-1: Impact of UL/DL Harmonic

UE UL carriers					fx_low	fx_high	fy_high	
UL frequency (MHz)					703	748	26500	29500
2 nd harmonics frequency limits (MHz)					2*fx_low	2*fx_high	2* fy_low	2* fy_high
2 nd harmonics frequency limits (MHz)					1406	1496	53000	59000
3 rd harmonics frequency limits					3*fx_low	3*fx_high	3* fy_low	3* fy_high
3 rd harmonics frequency limits					2109	2244	79500	88500

(MHz)				
4 th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4 th harmonics frequency limits (MHz)	2812	2992	106000	118000
5 th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5 th harmonics frequency limits (MHz)	3515	3740	132500	147500
6 th harmonics frequency limits	6*fx_low	6*fx_high	6* fy_low	6* fy_high
6 th harmonics frequency limits (MHz)	4218	4488	159000	177000
7 th harmonics frequency limits	7*fx_low	7*fx_high	7* fy_low	7* fy_high
7 th harmonics frequency limits (MHz)	4921	5236	185500	206500

8.14.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n-n257, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values for UEs not supporting simultaneous Rx/Tx are given in the tables below.

Table 8.14.1.4-1: $\Delta T_{IB,c}$

Inter-band EN-DC configuration	NR Band	$\Delta T_{IB,c}$ (dB)
CA_n28-n257	n28	0
	n257	0

Table 8.14.1.4-2: $\Delta R_{IB,c}$

Inter-band EN-DC configuration	NR Band	$\Delta R_{IB,c}$ (dB)
CA_n28-n257	n28	0
	n257	0

8.14.1.5 REFSEN requirements

As mentioned in section 8.14.1.3, REFSENSE due to harmonic is not expected.

8.14.2 Specific for 2 bands UL CA

8.14.2.1 UE co-existence studies

Table 8.14.2.1-1 lists Band n28 + Band n257 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 8.14.2.1-1: Band n28 and Band n257 UL IMD products

UE UL carriers	Fx_low	Fx_high	Fy_low	Fy_high

UL frequency (MHz)	703	748	26500	29500
2nd order IMD products	$ fy_{low} - fx_{high} $	$ fy_{high} - fx_{low} $	$ fy_{low} + fx_{low} $	$ fy_{high} + fx_{high} $
IMD frequency limits (MHz)	25752	28797	27203	30248
Two-tone 3rd order IMD products	$ 2*fx_{low} - fy_{high} $	$ 2*fx_{high} - fy_{low} $	$ 2*fy_{low} - fx_{high} $	$ 2*fy_{high} - fx_{low} $
IMD frequency limits (MHz)	28094	25004	52252	58297
Two-tone 3rd order IMD products	$ 2*fx_{low} + fy_{low} $	$ 2*fx_{high} + fy_{high} $	$ 2*fy_{low} + fx_{low} $	$ 2*fy_{high} + fx_{high} $
IMD frequency limits (MHz)	27906	30996	53703	59748
Two-tone 4th order IMD products	$ 3*fx_{low} - 1*fy_{high} $	$ 3*fx_{high} - 1*fy_{low} $	$ 3*fy_{low} - 1*fx_{high} $	$ 3*fy_{high} - 1*fx_{low} $
IMD frequency limits (MHz)	27391	24256	78752	87797
Two-tone 4th order IMD products	$ 2*fx_{low} - 2*fy_{high} $	$ 2*fx_{high} - 2*fy_{low} $		
IMD frequency limits (MHz)	51504	57594		
Two-tone 4th order IMD products	$ 3*fx_{low} + 1*fy_{low} $	$ 3*fx_{high} + 1*fy_{high} $	$ 3*fy_{low} + 1*fx_{low} $	$ 3*fy_{high} + 1*fx_{high} $
IMD frequency limits (MHz)	28609	31744	80203	89248
Two-tone 4th order IMD products	$ 2*fx_{low} + 2*fy_{low} $	$ 2*fx_{high} + 2*fy_{high} $		
IMD frequency limits (MHz)	54406	60496		
Two-tone 5th order IMD products	$ fx_{low} - 4*fy_{high} $	$ fx_{high} - 4*fy_{low} $	$ fy_{low} - 4*fx_{high} $	$ fy_{high} - 4*fx_{low} $
IMD frequency limits (MHz)	117297	105252	23508	26688
Two-tone 5th order IMD products	$ 2*fx_{low} - 3*fy_{high} $	$ 2*fx_{high} - 3*fy_{low} $	$ 2*fy_{low} - 3*fx_{high} $	$ 2*fy_{high} - 3*fx_{low} $
IMD frequency limits (MHz)	87094	78004	50756	56891
Two-tone 5th order IMD products	$ fx_{low} + 4*fy_{low} $	$ fx_{high} + 4*fy_{high} $	$ fy_{low} + 4*fx_{low} $	$ fy_{high} + 4*fx_{high} $
IMD frequency limits (MHz)	106703	118748	29312	32492
Two-tone 5th order IMD products	$ 2*fx_{low} + 3*fy_{low} $	$ 2*fx_{high} + 3*fy_{high} $	$ 2*fy_{low} + 3*fx_{low} $	$ 2*fy_{high} + 3*fx_{high} $
IMD frequency limits (MHz)	80906	89996	55109	61244

Based on Table 8.14.2.1-1, there are no IMD issues affecting own Rx frequencies of either band n28 or n257.

Table 8.14.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 8.14.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n28-n257	E-UTRA Band 1, 3, 5, 7, 8, 11, 18, 19, 20, 21, 26, 34, 39, 40, 41, 65	F_{DL_low}	-	F_{DL_high}	-50	1
	Frequency range	758	-	773	-32	1
	Frequency range	773	-	803	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3
NOTE 1: Applicable when co-existence with PHS system operating in 1884.5 - 1915.7 MHz						

8.14.2.2 REFSENS requirements

According to the co-existence analysis in 8.14.2.1 there is no need for additional REFSENS requirements for the 2DL/2UL configuration of CA_n28-n257.

8.15 CA_n5-n260

8.15.1 Common for 1 band UL and 2 bands UL CA

8.15.1.1 Operating bands for CA

Table 8.15.1.1-1: CA band combination of band n5+n260

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
	BS receive / UE transmit		BS transmit / UE receive			
	$F_{UL_low} - F_{UL_high}$		$F_{DL_low} - F_{DL_high}$			
n5	824 MHz – 849 MHz		869 MHz – 894 MHz		FDD	
n260	37000 MHz – 40000 MHz		37000 MHz – 40000 MHz		TDD	

8.15.1.2 Channel bandwidths per operating band for CA

Table 8.15.1.2-1: Supported bandwidths per CA band combination of band n5+n260

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	200 MHz	400 MHz	Band width combination set
CA_n5A-n260A	CA_n5 A-n260A	n5	15	Yes	Yes	Yes	Yes								0
			30		Yes	Yes	Yes								
			60												
		n260	60						Yes			Yes	Yes		
			120						Yes			Yes	Yes	Yes	
	CA_n5 A-n260(2A)	n5	15	Yes	Yes	Yes	Yes								0
			30		Yes	Yes	Yes								
			60												
		n260	See NR CA_n260(2A) Bandwidth Combination in Table 5.5A.2-1 of TS 38.101-2												
CA_n5A-n260(3A)	CA_n5 A-n260A	n5	15	Yes	Yes	Yes	Yes								0
			30		Yes	Yes	Yes								
			60												
		n260	See NR CA_n260(3A) Bandwidth Combination in Table 5.5A.2-1 of TS 38.101-2												
	CA_n5 A-n260(4A)	n5	15	Yes	Yes	Yes	Yes								0
			30		Yes	Yes	Yes								
			60												
		n260	See NR CA_n260(4A) Bandwidth Combination in Table 5.5A.2-1 of TS 38.101-2												
CA_n5A-n260(5A)	CA_n5 A-n260A	n5	15	Yes	Yes	Yes	Yes								0
			30		Yes	Yes	Yes								
			60												
		n260	See NR CA_n260(5A) Bandwidth Combination in Table 5.5A.2-1 of TS 38.101-2												
	CA_n5 A-n260(6A)	n5	15	Yes	Yes	Yes	Yes								0
			30		Yes	Yes	Yes								
			60												
		n260	See NR CA_n260(6A) Bandwidth Combination in Table 5.5A.2-1 of TS 38.101-2												
CA_n5A-n260(7A)	CA_n5 A-n260A	n5	15	Yes	Yes	Yes	Yes								0
			30		Yes	Yes	Yes								
			60												
		n260	See NR CA_n260(7A) Bandwidth Combination in Table 5.5A.2-1 of TS 38.101-2												
	CA_n5 A-n260(8A)	n5	15	Yes	Yes	Yes	Yes								0
			30		Yes	Yes	Yes								
			60												
		n260	See NR CA_n260(8A) Bandwidth Combination in Table 5.5A.2-1 of TS 38.101-2												

8.15.1.3 UE co-existence studies

Table 8.15.1.3-1 lists up to 7th harmonics for CA_n5-n260.

Table 8.15.1.3-1: Impact of UL/DL Harmonic

			2 nd Harmonic		3 rd Harmonic		4 th Harmonic		5 th Harmonic		6 th Harmonic		7 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n5	824	849	1648	1698	2472	2547	3296	3396	4120	4245	4944	5094	5768	5943
n260	37000	40000	74000	80000	111k	120k	148k	160k	185k	200k	222k	240k	259k	280k

8.15.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n5-n260, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are given in the tables below.

Table 8.15.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n5-n260	n5	0
	n260	0

Table 8.15.1.4-2: $\Delta R_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,c}$ [dB]
CA_n5-n260	n5	0
	n260	0

8.15.1.5 REFSENS requirements

There is no need for additional REFSENS requirements.

8.15.2 Specific for 2 bands UL CA

8.15.2.1 UE co-existence studies

Table 8.15.2.1-1 lists Band n5 +Band n260 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 8.15.2.1-1: Band n5 and Band n260 2UL bands IMD products

UE UL carriers	Fx_low	Fx_high	Fy_low	Fy_high
UL frequency (MHz)	824	849	37000	40000
2nd order IMD products	$ f_y_low - f_x_high $	$ f_y_high - f_x_low $	$ f_y_low + f_x_low $	$ f_y_high + f_x_high $
IMD frequency limits (MHz)	36151	39176	37824	40849
Two-tone 3rd order IMD products	$ 2*f_x_low - f_y_high $	$ 2*f_x_high - f_y_low $	$ 2*f_y_low - f_x_high $	$ 2*f_y_high - f_x_low $
IMD frequency limits (MHz)	35302	38352	73151	79176
Two-tone 3rd order IMD products	$ 2*f_x_low + f_y_low $	$ 2*f_x_high + f_y_high $	$ 2*f_y_low + f_x_low $	$ 2*f_y_high + f_x_high $
IMD frequency limits (MHz)	38648	41698	74824	80849
Two-tone 4th order IMD products	$ 3*f_x_low - 1*$	$ 3*f_x_high - 1*$	$ 3*f_y_low - 1*f_x_high $	$ 3*f_y_high - 1*f_x_low $

	$ fy_{high} $	$ 1*fy_{low} $		
IMD frequency limits (MHz)	34453	37528	110151	119176
Two-tone 4th order IMD products	$ 2*fx_{low} - 2*fy_{high} $	$ 2*fx_{high} - 2*fy_{low} $	$ 2*fx_{low} + 2*fy_{low} $	$ 2*fx_{high} + 2*fy_{high} $
IMD frequency limits (MHz)	72302	78352	75648	81698
Two-tone 4th order IMD products	$ 3*fx_{low} + 1*fy_{low} $	$ 3*fx_{high} + 1*fy_{high} $	$ 3*fy_{low} + 1*fx_{low} $	$ 3*fy_{high} + 1*fx_{high} $
IMD frequency limits (MHz)	39472	42547	111824	120849
Two-tone 5th order IMD products	$ fx_{low} - 4*fy_{high} $	$ fx_{high} - 4*fy_{low} $	$ fy_{low} - 4*fx_{high} $	$ fy_{high} - 4*fx_{low} $
IMD frequency limits (MHz)	147151	159176	33604	36704
Two-tone 5th order IMD products	$ 2*fx_{low} - 3*fy_{high} $	$ 2*fx_{high} - 3*fy_{low} $	$ 2*fy_{low} - 3*fx_{high} $	$ 2*fy_{high} - 3*fx_{low} $
IMD frequency limits (MHz)	109302	118352	71453	77528
Two-tone 5th order IMD products	$ fx_{low} + 4*fy_{low} $	$ fx_{high} + 4*fy_{high} $	$ fy_{low} + 4*fx_{low} $	$ fy_{high} + 4*fx_{high} $
IMD frequency limits (MHz)	148824	160849	40296	43396
Two-tone 5th order IMD products	$ 2*fx_{low} + 3*fy_{low} $	$ 2*fx_{high} + 3*fy_{high} $	$ 2*fy_{low} + 3*fx_{low} $	$ 2*fy_{high} + 3*fx_{high} $
IMD frequency limits (MHz)	112648	121698	76472	82547

Table 8.15.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 8.15.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n5A-n260A	E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 10, 12, 13, 14, 17, 18, 19, 24, 25, 26, 28, 29, 30, 31, 34, 38, 40, 42, 43, 45, 48, 50, 51, 65, 66, 70, 71, 73, 74, 85	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 41, 52	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3 PHS

8.15.2.2 REFSENS requirements

There is no need for additional REFSENS requirements.

8.16 CA_n5-n261

8.16.1 Common for 1 band UL and 2 bands UL CA

8.16.1.1 Operating bands for CA

Table 8.16.1.1-1: CA band combination of band n5+n261

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode	
	BS receive / UE transmit		BS transmit / UE receive			
	$F_{UL_low} - F_{UL_high}$		$F_{DL_low} - F_{DL_high}$			
n5	824 MHz – 849 MHz		869 MHz – 894 MHz		FDD	
n261	27500 MHz – 28350 MHz		27500 MHz – 28350 MHz		TDD	

8.16.1.2 Channel bandwidths per operating band for CA

Table 8.16.1.2-1: Supported bandwidths per CA band combination of band n5+n261

NR CA configuration	Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	200 MHz	400 MHz	Band width combination set	
CA_n5A-n261A	-	n5	15	Yes	Yes	Yes	Yes								0	
			30		Yes	Yes	Yes									
			60													
		n261	60						Yes			Yes	Yes		0	
			120						Yes			Yes	Yes	Yes		
		n5	15	Yes	Yes	Yes	Yes								0	
			30		Yes	Yes	Yes									
			60													
CA_n5A-n261(2A)		n261	See NR CA_n261(2A) Bandwidth Combination in Table 5.5A.2-1 of TS 38.101-2												0	
			See NR CA_n261(3A) Bandwidth Combination in Table 5.5A.2-1 of TS 38.101-2													
			See NR CA_n261(4A) Bandwidth Combination in Table 5.5A.2-1 of TS 38.101-2													
		n5	15	Yes	Yes	Yes	Yes								0	
			30		Yes	Yes	Yes									
			60													
CA_n5A-n261(3A)		n261	See NR CA_n261(3A) Bandwidth Combination in Table 5.5A.2-1 of TS 38.101-2												0	
			See NR CA_n261(4A) Bandwidth Combination in Table 5.5A.2-1 of TS 38.101-2													
			See NR CA_n261G Bandwidth Combination in Table 5.5A.1-1 of TS 38.101-2													
		n5	15	Yes	Yes	Yes	Yes								0	
			30		Yes	Yes	Yes									
			60													
CA_n5A-n261G	CA_n5A-n261A CA_n5A-n261G	n5	See NR CA_n261G Bandwidth Combination in Table 5.5A.1-1 of TS 38.101-2												0	
			See NR CA_n261H Bandwidth Combination in Table 5.5A.1-1 of TS 38.101-2													
			See NR CA_n261I Bandwidth Combination in Table 5.5A.1-1 of TS 38.101-2													
		n261	See NR CA_n261H Bandwidth Combination in Table 5.5A.1-1 of TS 38.101-2												0	
			See NR CA_n261I Bandwidth Combination in Table 5.5A.1-1 of TS 38.101-2													
			See NR CA_n261J Bandwidth Combination in Table 5.5A.1-1 of TS 38.101-2													
CA_n5A-n261I	CA_n5A-n261A CA_n5A-n261G CA_n5A-n261H CA_n5A-n261I	n5	15	Yes	Yes	Yes	Yes								0	
			30		Yes	Yes	Yes									
			60													
		n261	See NR CA_n261I Bandwidth Combination in Table 5.5A.1-1 of TS 38.101-2												0	
			See NR CA_n261J Bandwidth Combination in Table 5.5A.1-1 of TS 38.101-2													
			See NR CA_n261J Bandwidth Combination in Table 5.5A.1-1 of TS 38.101-2													
			See NR CA_n261J Bandwidth Combination in Table 5.5A.1-1 of TS 38.101-2													
CA_n5A-n261J	CA_n5A-n261A CA_n5A-n261G CA_n5A-n261H CA_n5A-n261I	n5	15	Yes	Yes	Yes	Yes								0	
			30		Yes	Yes	Yes									
			60													
		n261	See NR CA_n261J Bandwidth Combination in Table 5.5A.1-1 of TS 38.101-2												0	
			See NR CA_n261J Bandwidth Combination in Table 5.5A.1-1 of TS 38.101-2													
			See NR CA_n261J Bandwidth Combination in Table 5.5A.1-1 of TS 38.101-2													
			See NR CA_n261J Bandwidth Combination in Table 5.5A.1-1 of TS 38.101-2													
CA_n5A-	CA_n5	n5	15	Yes	Yes	Yes	Yes								0	

8.16.1.3 UE co-existence studies

Table 8.16.1.3-1 lists up to 7th harmonics for CA _ n5-n261.

Table 8.16.1.3-1: Impact of UL/DL Harmonic

			2 nd Harmonic		3 rd Harmonic		4 th Harmonic		5 th Harmonic		6 th Harmonic		7 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n5	824	849	1648	1698	2472	2547	3296	3396	4120	4245	4944	5094	5768	5943
n261	27500	28350	55000	56700	82500	85050	1100 00	1134 00	13750 0	141750	16500 0	17010 0	19250 0	19845 0

8.16.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n5-n261, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are given in the tables below.

Table 8.16.1.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n5-n261	n5	0
	n261	0

Table 8.16.1.4-2: $\Delta R_{B,c}$

Inter-band CA Configuration	NR Band	$\Delta R_{IB,C}$ [dB]
CA_n5-n261	n5	0
	n261	0

8.16.1.5 REFSENS requirements

There is no need for additional REFSENS requirements.

8.16.2 Specific for 2 bands UL CA

8.16.2.1 UE co-existence studies

Table 8.16.2.1-1 lists Band n5 + Band n261 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 8.16.2.1-1: Band n5 and Band n261 2UL bands IMD products

UE UL carriers	F _{x_low}	F _{x_high}	F _{y_low}	F _{y_high}
UL frequency (MHz)	824	849	27500	28350
2nd order IMD products	f _{y_low} – f _{x_high}	f _{y_high} – f _{x_low}	f _{y_low} + f _{x_low}	f _{y_high} + f _{x_high}
IMD frequency limits (MHz)	26651	27526	28324	29199
Two-tone 3rd order IMD products	2*f _{x_low} – f _{y_high}	2*f _{x_high} – f _{y_low}	2*f _{y_low} – f _{x_high}	2*f _{y_high} – f _{x_low}
IMD frequency limits (MHz)	25802	26702	54151	55876
Two-tone 3rd order IMD products	2*f _{x_low} + f _{y_low}	2*f _{x_high} + f _{y_high}	2*f _{y_low} + f _{x_low}	2*f _{y_high} + f _{x_high}
IMD frequency limits (MHz)	29148	30048	55824	57549
Two-tone 4th order IMD products	3*f _{x_low} – 1*f _{y_high}	3*f _{x_high} – 1*f _{y_low}	3*f _{y_low} – 1*f _{x_high}	3*f _{y_high} – 1*f _{x_low}
IMD frequency limits (MHz)	24953	25878	81651	84226
Two-tone 4th order IMD products	2*f _{x_low} – 2*f _{y_high}	2*f _{x_high} – 2*f _{y_low}	2*f _{x_low} + 2*f _{y_low}	2*f _{x_high} + 2*f _{y_high}
IMD frequency limits (MHz)	53302	55052	56648	58398
Two-tone 4th order IMD products	3*f _{x_low} + 1*f _{y_low}	3*f _{x_high} + 1*f _{y_high}	3*f _{y_low} + 1*f _{x_low}	3*f _{y_high} + 1*f _{x_high}

IMD frequency limits (MHz)	29972	30897	83324	85899
Two-tone 5th order IMD products	$ fx_{low} - 4*fy_{high} $	$ fx_{high} - 4*fy_{low} $	$ fy_{low} - 4*fx_{high} $	$ fy_{high} - 4*fx_{low} $
IMD frequency limits (MHz)	109151	112576	24104	25054
Two-tone 5th order IMD products	$ 2*fx_{low} - 3*fy_{high} $	$ 2*fx_{high} - 3*fy_{low} $	$ 2*fy_{low} - 3*fx_{high} $	$ 2*fy_{high} - 3*fx_{low} $
IMD frequency limits (MHz)	80802	83402	52453	54228
Two-tone 5th order IMD products	$ fx_{low} + 4*fy_{low} $	$ fx_{high} + 4*fy_{high} $	$ fy_{low} + 4*fx_{low} $	$ fy_{high} + 4*fx_{high} $
IMD frequency limits (MHz)	110824	114249	30796	31746
Two-tone 5th order IMD products	$ 2*fx_{low} + 3*fy_{low} $	$ 2*fx_{high} + 3*fy_{high} $	$ 2*fy_{low} + 3*fx_{low} $	$ 2*fy_{high} + 3*fx_{high} $
IMD frequency limits (MHz)	84148	86748	57472	59247

Table 8.16.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 8.16.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n5A-n261A	E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 10, 12, 13, 14, 17, 18, 19, 24, 25, 26, 28, 29, 30, 31, 34, 38, 40, 42, 43, 45, 48, 50, 51, 65, 66, 70, 71, 73, 74, 85	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 41, 52	F_{DL_low}	-	F_{DL_high}	-50	1
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3

8.16.2.2 REFSENS requirements

There is no need for additional REFSENS requirements.

8.17 CA_n77-n261

8.17.1 Common for 1 band UL and 2 bands UL CA

8.17.1.1 Operating bands for CA

Table 8.17.1.1-1: CA band combination of band n77+n261

NR Band	Uplink (UL) band	Downlink (DL) band	Duplex mode
	BS receive / UE transmit	BS transmit / UE receive	
	$F_{UL_low} - F_{UL_high}$	$F_{DL_low} - F_{DL_high}$	
n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	TDD
n261	27500 MHz – 28350 MHz	27500 MHz – 28350 MHz	TDD

8.17.1.2 Channel bandwidths per operating band for CA

Table 8.17.1.2-1: Supported bandwidths per CA band combination of band n77+n261

NR CA configuration / Bandwidth combination set

NR CA configuration	NR Uplink CA configuration	NR Band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	70 MHz	80 MHz	90 MHz	100 MHz	200 MHz	400 MHz	BCS
CA_n77A-n261A	CA_n77A-n261A	n77	15		Yes	Yes	Yes			Yes	Yes								0
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes ⁴	Yes	Yes	Yes			
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes ⁴	Yes	Yes	Yes			
			60								Yes					Yes	Yes	Yes	
	CA_n77A-n261D CA_n77A-n261D	n77	120								Yes					Yes	Yes	Yes	0
			15		Yes	Yes	Yes			Yes	Yes								
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes ⁴	Yes	Yes	Yes			0
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes ⁴	Yes	Yes	Yes			
CA_n77A-n261G	CA_n77A-n261A CA_n77A-n261G	n77	n261	See CA_n261D in Table 5.5A.1-2 in TS 38.101-2															0
			15		Yes	Yes	Yes			Yes	Yes								
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes ⁴	Yes	Yes	Yes			
	CA_n77A-n261G	n261	See CA_n261G in Table 5.5A.1-2 in TS 38.101-2																0
CA_n77A-n261H	CA_n77A-n261A CA_n77A-n261G CA_n77A-n261H	n77	15		Yes	Yes	Yes			Yes	Yes								0
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes ⁴	Yes	Yes	Yes			
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes ⁴	Yes	Yes	Yes			
		n261	See CA_n261H in Table 5.5A.1-2 in TS 38.101-2																0
CA_n77A-n261I	CA_n77A-n261A CA_n77A-n261G CA_n77A-n261H CA_n77A-n261I	n77	15		Yes	Yes	Yes			Yes	Yes								0
			30		Yes	Yes	Yes			Yes	Yes	Yes	Yes ⁴	Yes	Yes	Yes			
			60		Yes	Yes	Yes			Yes	Yes	Yes	Yes ⁴	Yes	Yes	Yes			
		n261	See CA_n261I in Table 5.5A.1-2 in TS 38.101-2																0
CA_n77A-n261J	CA_n77A-n261A CA_n77A-n261G CA_n77A-n261H CA_n77A-n261I CA_n77A-n261J	n77	15		Yes							0							
			30		Yes	Yes ⁴	Yes	Yes	Yes	Yes	Yes								
			60		Yes	Yes ⁴	Yes	Yes	Yes	Yes	Yes								
		n261	See CA_n261J in Table 5.5A.1-1 in TS 38.101-2																0
CA_n77A-n261K	CA_n77A-n261A CA_n77A-n261G CA_n77A-n261H CA_n77A-n261I CA_n77A-n261J	n77	15		Yes							0							
			30		Yes	Yes ⁴	Yes	Yes	Yes	Yes	Yes								
			60		Yes	Yes ⁴	Yes	Yes	Yes	Yes	Yes								
		n261	See CA_n261K in Table 5.5A.1-1 in TS 38.101-2																0

CA_n77A-n261L	CA_n77A-n261A CA_n77A-n261G	n77	15		Yes													
			30		Yes ⁴	Yes	Yes	Yes	Yes									
			60		Yes ⁴	Yes	Yes	Yes	Yes									
		n261	See CA_n261L in Table 5.5A.1-1 in TS 38.101-2															
CA_n77A-n261M	CA_n77A-n261A CA_n77A-n261G CA_n77A-n261H CA_n77A-n261I CA_n77A-n261J CA_n77A-n261K CA_n77A-n261L CA_n77A-n261M	n77	15		Yes													
			30		Yes ⁴	Yes	Yes	Yes	Yes									
			60		Yes ⁴	Yes	Yes	Yes	Yes									
		n261	See CA_n261M in Table 5.5A.1-1 in TS 38.101-2															
CA_n77A-n261(2A)	CA_n77A-n261A	n77	15		Yes													
			30		Yes ⁴	Yes	Yes	Yes	Yes									
			60		Yes ⁴	Yes	Yes	Yes	Yes									
		n261	See CA_n261(2A) in Table 5.5A.2-1 in TS 38.101-2															
CA_n77A-n261(2G)	CA_n77A-n261A	n77	15		Yes													
			30		Yes ⁴	Yes	Yes	Yes	Yes									
			60		Yes ⁴	Yes	Yes	Yes	Yes									
		n261	See CA_n261(2G) in Table 5.5A.2-1 in TS 38.101-2															
CA_n77A-n261(2H)	CA_n77A-n261A	n77	15		Yes													
			30		Yes ⁴	Yes	Yes	Yes	Yes									
			60		Yes ⁴	Yes	Yes	Yes	Yes									
		n261	See CA_n261(2H) in Table 5.5A.2-1 in TS 38.101-2															
CA_n77A-n261(2I)	CA_n77A-n261A	n77	15		Yes													
			30		Yes ⁴	Yes	Yes	Yes	Yes									
			60		Yes ⁴	Yes	Yes	Yes	Yes									
		n261	See CA_n261(2I) in Table 5.5A.2-1 in TS 38.101-2															
CA_n77A-n261(3A)	CA_n77A-n261A	n77	15		Yes													
			30		Yes ⁴	Yes	Yes	Yes	Yes									
			60		Yes ⁴	Yes	Yes	Yes	Yes									
		n261	See CA_n261(3A) in Table 5.5A.2-1 in TS 38.101-2															

CA_n77A-n261(4A)	CA_n77A-n261A	n77	15		Yes								0						
			30		Yes ⁴	Yes	Yes	Yes	Yes										
			60		Yes ⁴	Yes	Yes	Yes	Yes										
		n261	See CA_n261(4A) in Table 5.5A.2-1 in TS 38.101-2																
CA_n77A-n261(A-G)	CA_n77A-n261A	n77	15		Yes							0							
			30		Yes ⁴	Yes	Yes	Yes	Yes										
			60		Yes ⁴	Yes	Yes	Yes	Yes										
		n261	See CA_n261(A-G) in Table 5.5A.2-2 in TS 38.101-2																
CA_n77A-n261(A-H)	CA_n77A-n261A	n77	15		Yes							0							
			30		Yes ⁴	Yes	Yes	Yes	Yes										
			60		Yes ⁴	Yes	Yes	Yes	Yes										
		n261	See CA_n261(A-H) in Table 5.5A.2-2 in TS 38.101-2																
CA_n77A-n261(A-I)	CA_n77A-n261A	n77	15		Yes							0							
			30		Yes ⁴	Yes	Yes	Yes	Yes										
			60		Yes ⁴	Yes	Yes	Yes	Yes										
		n261	See CA_n261(A-I) in Table 5.5A.2-2 in TS 38.101-2																
CA_n77A-n261(G-H)	CA_n77A-n261A	n77	15		Yes							0							
			30		Yes ⁴	Yes	Yes	Yes	Yes										
			60		Yes ⁴	Yes	Yes	Yes	Yes										
		n261	See CA_n261(G-H) in Table 5.5A.2-2 in TS 38.101-2																
CA_n77A-n261(G-I)	CA_n77A-n261A	n77	15		Yes							0							
			30		Yes ⁴	Yes	Yes	Yes	Yes										
			60		Yes ⁴	Yes	Yes	Yes	Yes										
		n261	See CA_n261(G-I) in Table 5.5A.2-1 in TS 38.101-2																
CA_n77A-n261(H-I)	CA_n77A-n261A	n77	15		Yes							0							
			30		Yes ⁴	Yes	Yes	Yes	Yes										
			60		Yes ⁴	Yes	Yes	Yes	Yes										
		n261	See CA_n261(H-I) in Table 5.5A.2-2 in TS 38.101-2																

NOTE 4: This UE channel bandwidth is optional in this release of the specification. (From Table 5.3.5-1 of 38.101-1)

8.17.1.3 Co-existence studies

Table 8.17.1.3-1 gives the UL 2nd, 3rd, 4th, 5th, 6th, 7th harmonic for CA_n77A-n261A. The 6th and 7th harmonic produced by UL band n77 may fall into Band n261DL.

Table 8.17.1.3-1: Band n77 and Band n258 UL harmonics products

UE UL carriers	fx_low	fx_high	<bfy_low< b=""></bfy_low<>	<bfy_high< b=""></bfy_high<>
UL frequency(MHz)	3300	4200	27500	28350
2nd harmonics frequency limits	2*fx_low	2*fx_high	2*fy_low	2*fy_high
2nd harmonics frequency limits(MHz)	6600	8400	55000	56700
3rd harmonics frequency limits	3*fx_low	3*fx_high	3*fy_low	3*fy_high
3rd harmonics frequency limits(MHz)	9900	12600	82500	85050
4th harmonics frequency limits	4*fx_low	4*fx_high	4*fy_low	4*fy_high
4th harmonics frequency limits(MHz)	13200	16800	110000	113400
5th harmonics frequency limits	5*fx_low	5*fx_high	5*fy_low	5*fy_high
5th harmonics frequency limits(MHz)	16500	21000	137500	141750
6th harmonics frequency limits	6*fx_low	6*fx_high	6*fy_low	6*fy_high
6th harmonics frequency limits(MHz)	19800	25200	165000	170100
7th harmonics frequency limits	7*fx_low	7*fx_high	7*fy_low	7*fy_high
7th harmonics frequency limits(MHz)	23100	29400	192500	198450

8.17.1.4 ΔT_{IB} and ΔR_{IB} values

For CA_n77A-n261A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 8.17.4-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n77-n261	n77	0
	n261	0

Table 8.17.4-2: ΔR_{IB}

Inter-band CA Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
CA_n77-n261	n77	0
	n261	0

8.17.1.5 REFSENS requirements

There are no specific REFSENS requirements for this configuration.

8.17.2 Specific for 2 bands UL CA

8.17.2.1 UE co-existence studies

Table 8.17.2.1-1 lists Band n77 +Band n261 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 8.17.2.1-1: Band n77 and Band n261 2UL bands IMD products

UE UL carriers	Fx_low	Fx_high	Fy_low	Fy_high
UL frequency (MHz)	3300	4200	27500	28350
2nd order IMD products	$ fy_{low} - fx_{high} $	$ fy_{high} - fx_{low} $	$ fy_{low} + fx_{low} $	$ fy_{high} + fx_{high} $
IMD frequency limits (MHz)	23300	25050	30800	32550
Two-tone 3rd order IMD products	$ 2*fx_{low} - fy_{high} $	$ 2*fx_{high} - fy_{low} $	$ 2*fy_{low} - fx_{high} $	$ 2*fy_{high} - fx_{low} $
IMD frequency limits (MHz)	21750	19100	50800	53400
Two-tone 3rd order IMD products	$ 2*fx_{low} + fy_{low} $	$ 2*fx_{high} + fy_{high} $	$ 2*fy_{low} + fx_{low} $	$ 2*fy_{high} + fx_{high} $
IMD frequency limits (MHz)	34100	36750	58300	60900
Two-tone 4th order IMD products	$ 3*fx_{low} - 1*fy_{high} $	$ 3*fx_{high} - 1*fy_{low} $	$ 3*fy_{low} - 1*fx_{high} $	$ 3*fy_{high} - 1*fx_{low} $
IMD frequency limits (MHz)	18450	14900	78300	81750
Two-tone 4th order IMD products	$ 2*fx_{low} - 2*fy_{high} $	$ 2*fx_{high} - 2*fy_{low} $		
IMD frequency limits (MHz)	46600	50100		
Two-tone 4th order IMD products	$ 3*fx_{low} + 1*fy_{low} $	$ 3*fx_{high} + 1*fy_{high} $	$ 3*fy_{low} + 1*fx_{low} $	$ 3*fy_{high} + 1*fx_{high} $
IMD frequency limits (MHz)	37400	40950	85800	89250
Two-tone 4th order IMD products	$ 2*fx_{low} + 2*fy_{low} $	$ 2*fx_{high} + 2*fy_{high} $		
IMD frequency limits (MHz)	61600	65100		
Two-tone 5th order IMD products	$ fx_{low} - 4*fy_{high} $	$ fx_{high} - 4*fy_{low} $	$ fy_{low} - 4*fx_{high} $	$ fy_{high} - 4*fx_{low} $
IMD frequency limits (MHz)	110100	105800	10700	15150
Two-tone 5th order IMD products	$ 2*fx_{low} - 3*fy_{high} $	$ 2*fx_{high} - 3*fy_{low} $	$ 2*fy_{low} - 3*fx_{high} $	$ 2*fy_{high} - 3*fx_{low} $
IMD frequency limits (MHz)	78450	74100	42400	46800
Two-tone 5th order IMD products	$ fx_{low} + 4*fy_{low} $	$ fx_{high} + 4*fy_{high} $	$ fy_{low} + 4*fx_{low} $	$ fy_{high} + 4*fx_{high} $
IMD frequency limits (MHz)	113300	117600	40700	45150

Two-tone 5th order IMD products	$ 2*fx_{low} + 3*fy_{low} $	$ 2*fx_{high} + 3*fy_{high} $	$ 2*fy_{low} + 3*fx_{low} $	$ 2*fy_{high} + 3*fx_{high} $
IMD frequency limits (MHz)	89100	93450	64900	69300

Based on Table 8.17.2.1-1, there are no harmonic or IMD issues affecting own Rx frequencies of either band n77 or n261.

Table 8.17.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

Table 8.17.2.1-2: Protected bands for the 2UL bands CA configuration

UL NR CA Configuration	Spurious emission						
	Protected band		Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n77A-n261A	E-UTRA Band 2, 4, 5, 12, 13, 14, 17, 25, 26, 29, 30, 65, 66, 70, 71	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS

8.17.2.2 REFSENS requirements

There are no need for additional REFSENS requirements for this configuration.

8.18 CA_n66_n260

8.18.1 Common for 1 band UL and 2 bands UL CA

8.18.1.1 Operating bands for CA

Table 8.18.1.1-1: CA band combination of n66+n260

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode
	BS receive / UE transmit	BS transmit / UE receive	BS transmit / UE receive	BS receive / UE transmit	
n66	1710 MHz – 1780 MHz		2110 MHz – 2200 MHz		FDD
n260	37000 MHz - 40000 MHz		37000 MHz - 40000 MHz		TDD

8.18.1.2 Channel bandwidths per operating band for CA

Table 8.18.1.2-1: Supported bandwidths per CA band combination of band n66+n260

CA operating / channel bandwidth [MHz]															
NR CA Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	40	50	60	80	100	200	400	Bandwidth combination set
CA_n66A-n260A	CA_n66A-n260A	n66	15	Yes	Yes	Yes	Yes			Yes					0
			30		Yes	Yes	Yes			Yes					
			60		Yes	Yes	Yes			Yes					
	n260		See CA_n260A in Table 5.5A.2-1 in TS 38.101-2												
CA_n66A-	CA_n66A-	n66	15	Yes	Yes	Yes	Yes			Yes					0

8.18.1.3 Co-existence studies

Table 8.18.1.3-1: Impact of UL/DL Harmonic

			2 nd Harmonic		3 rd Harmonic		4 th Harmonic		5 th Harmonic		6 th Harmonic		7 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge	UL Low Band Edge	UL High Band Edge
n66	1710	1780	3420	3560	5130	5340	6840	7120	8550	8900	10260	10680	11970	12460
n260	37000	40000	74000	80000	111000	120000	148000	160000	185000	200000	222000	240000	259000	280000

Based on Table 8.18.1.3-1, there is no harmonic skirt interference found to impact the receive frequency of each band. And, no further studies are needed for this combination.

8.18.1.4 Δ TIB and Δ RIB values

For CA_n66A-n260A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 8.18.5-1: $\Delta T_{IB,c}$

Inter-band CA Configuration	NR Band	$\Delta T_{IB,c}$ [dB]
CA_n66A-n260A	n66	0
	n260	0

8.18.1.5 REFSENS requirements

There is no need for additional REFSENS requirements.

8.19 CA_n66_n261

8.19.1 Common for 1 band UL and 2 bands UL CA

8.19.1.1 Operating bands for CA

Table 8.19.1.1-1: CA band combination of band n66+n261

NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode
	BS receive / UE transmit	BS transmit / UE receive	BS receive / UE transmit	BS transmit / UE receive	
n66	824 MHz - 849 MHz		869 MHz - 894 MHz		FDD
n261	27500 MHz - 28350 MHz		27500 MHz - 28350 MHz		TDD

8.19.1.2 Channel bandwidths per operating band for CA

Table 8.19.1.2-1: Supported bandwidths per CA band combination of band n66+n261

CA operation / channel bandwidth [MHz]															
NR DC Configuration	UL Configuration	NR Band	SCS [kHz]	5	10	15	20	40	50	60	80	100	200	400	Bandwidth combination set
CA_n66A-n261A	CA_n66A-n261A	n66	15	Yes	Yes	Yes	Yes	Yes							0
			30		Yes	Yes	Yes	Yes							
			60		Yes	Yes	Yes	Yes							
		n261	See CA_n261A in Table 5.5A.2-1 in TS 38.101-2												
CA_n66A-n261(2A)	CA_n66A-n261A	n66	15	Yes	Yes	Yes	Yes	Yes							0
			30		Yes	Yes	Yes	Yes							
			60		Yes	Yes	Yes	Yes							
		n261	See CA_n261(2A) in Table 5.5A.2-1 in TS 38.101-2												
CA_n66A-n261(3A)	CA_n66A-n261A	n66	15	Yes	Yes	Yes	Yes	Yes							0
			30		Yes	Yes	Yes	Yes							
			60		Yes	Yes	Yes	Yes							
		n261	See CA_n261(3A) in Table 5.5A.2-1 in TS 38.101-2												
CA_n66A-n261(4A)	CA_n66A-n261A	n66	15	Yes	Yes	Yes	Yes	Yes							0
			30		Yes	Yes	Yes	Yes							
			60		Yes	Yes	Yes	Yes							
		n261	See CA_n261(4A) in Table 5.5A.2-1 in TS 38.101-2												
CA_n66A-n261G	CA_n66A-n261A CA_5A_n261G	n66	15	Yes	Yes	Yes	Yes	Yes							0
			30		Yes	Yes	Yes	Yes							
			60		Yes	Yes	Yes	Yes							
		n261	See CA_n261G in Table 5.5A.1-1 in TS 38.101-2												
CA_n66A-n261H	CA_n66A-n261A CA_n66A_n261G CA_n66A_n261H	n66	15	Yes	Yes	Yes	Yes	Yes							0
			30		Yes	Yes	Yes	Yes							
			60		Yes	Yes	Yes	Yes							
		n261	See CA_n261H in Table 5.5A.1-1 in TS 38.101-2												
CA_n66A-n261I	CA_n66A-n261A CA_n66A_n261G CA_n66A_n261H CA_n66A_n261I	n66	15	Yes	Yes	Yes	Yes	Yes							0
			30		Yes	Yes	Yes	Yes							
			60		Yes	Yes	Yes	Yes							
		n261	See CA_n261I in Table 5.5A.1-1 in TS 38.101-2												
CA_n66A-	CA_n66A-n261A	n66	15	Yes	Yes	Yes	Yes	Yes							0

8.19.1.3 Co-existence studies

			2 nd Harmonic		3 rd Harmonic		4 th Harmonic		5 th Harmonic		6 th Harmonic		7 th Harmonic	
Band	UL Low Band Edge	UL High Band Edge												
n66	1710	1780	3420	3560	5130	5340	6840	7120	8550	8900	10260	10680	11970	12460
n261	27500	28350	55000	56700	82500	85050	110000	113400	137500	141750	165000	170100	192500	198450

Based on Table 8.19.1.3-1, there is no harmonic skirt interference found to impact the receive frequency of each band. And, no further studies are needed for this combination.

8.19.1.4 Δ TIB and Δ RIB values

For CA_n66A-n261A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 8.19.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	NR Band	$\Delta T_{IB,C}$ [dB]
CA_n66A-n261A	n66	0
	n261	0

Table 8.19.4-2: ΔR_{IB}

Inter-band DC Configuration	NR Band	ΔR_{IB} [dB]
CA_n66A-n261A	n66	0
	n261	0

8.19.1.5 REFSENS requirements

There is no need for additional REFSENS requirements.

Table 8.18.5-2: ΔR_{IB}

Inter-band CA Configuration	NR Band	ΔR_{IB} [dB]
CA_n66A-n260A	n66	0
	n260	0

9 2 bands Dual Connectivity: Specific Band Combination Part

9.1 DC_n2-n77

9.1.1 Operating bands for DC_n2-n77

Table 9.1.1-1: Inter-band NR DC operating bands

NR DC Band	NR Band
DC_n2-n77	n2, n77

9.1.2 Configurations for DC_n2-n77

Table 9.1.2-1: Inter-band NR DC configurations

NR DC configuration	Uplink NR DC configuration
DC_n2A-n77A	DC_n2A-n77A

9.2 DC_n5-n77

9.2.1 Operating bands for DC_n5-n77

Table 9.2.1-1: Inter-band NR DC operating bands

NR DC Band	NR Band
DC_n5-n77	n5, n77

9.2.2 Configurations for DC_n5-n77

Table 9.2.2-1: Inter-band NR DC configurations

NR DC configuration	Uplink NR DC configuration
DC_n5A-n77A	DC_n5A-n77A

9.3 DC_n66-n77

9.3.1 Operating bands for DC_n66-n77

Table 9.3.1-1: Inter-band NR DC operating bands

NR DC Band	NR Band
DC_n66-n77	n66, n77

9.3.2 Configurations for DC_n66-n77

Table 9.3.2-1: Inter-band NR DC configurations

NR DC configuration	Uplink NR DC configuration
DC_n66A-n77A	DC_n66A-n77A

9.4 DC_n77-n261

9.4.1 Operating bands for DC_n77-n261

Table 9.4.1-1: Inter-band NR DC operating bands

NR DC Band	NR Band
DC_n77-n261	n77, n261

9.4.2 Configurations for DC_n77-n261

Table 9.4.2-1: Inter-band NR DC configurations

NR DC configuration	Uplink NR DC configuration
DC_n77A-n261A	DC_n77A-n261A
DC_n77A-n261D	DC_n77A-n261A DC_n77A-n261D
DC_n77A-n261G	DC_n77A-n261A DC_n77A-n261G
DC_n77A-n261H	DC_n77A-n261A DC_n77A-n261G DC_n77A-n261H
DC_n77A-n261I	DC_n77A-n261A DC_n77A-n261G DC_n77A-n261H DC_n77A-n261I
DC_n77A-n261J	DC_n77A-n261A DC_n77A-n261G DC_n77A-n261H DC_n77A-n261I DC_n77A-n261J
DC_n77A-n261K	DC_n77A-n261A DC_n77A-n261G DC_n77A-n261H DC_n77A-n261I DC_n77A-n261J DC_n77A-n261K
DC_n77A-n261L	DC_n77A-n261A DC_n77A-n261G DC_n77A-n261H DC_n77A-n261I DC_n77A-n261J DC_n77A-n261K DC_n77A-n261L

NR DC configuration	Uplink NR DC configuration
DC_n77A-n261M	DC_n77A-n261A DC_n77A-n261G DC_n77A-n261H DC_n77A-n261I DC_n77A-n261J DC_n77A-n261K DC_n77A-n261L DC_n77A-n261M
DC_n77A-n261(2A)	DC_n77A-n261A
DC_n77A-n261(2G)	DC_n77A-n261A
DC_n77A-n261(2H)	DC_n77A-n261A
DC_n77A-n261(2I)	DC_n77A-n261A
DC_n77A-n261(3A)	DC_n77A-n261A
DC_n77A-n261(4A)	DC_n77A-n261A
DC_n77A-n261(A-G)	DC_n77A-n261A
DC_n77A-n261(A-H)	DC_n77A-n261A
DC_n77A-n261(A-I)	DC_n77A-n261A
DC_n77A-n261(G-H)	DC_n77A-n261A
DC_n77A-n261(G-I)	DC_n77A-n261A
DC_n77A-n261(H-I)	DC_n77A-n261A

Annex A:

Change history

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2018-08	RAN4#8	R4-1810913				TR skeleton	0.0.1
2018-10	RAN4#8bis	R4-1812524				Implemented TP's from RAN4 #88: R4-1810177, TP for TR 38.716-02-00: CA_n3A-n79A, ZTE corporation R4-1811447, TP for TR38.716-02-00 1UL and 2UL for CA_n1-n78, ZTE corporation R4-1810343, TP for TR38.716-02-00: Requirements for CA_n66A-n71A and CA_n66A-n70A, Dish Network R4-1810451, 2UL UE co-ex: a problem in co-ex table, SoftBank Corp.	0.1.0
2018-11	RAN4#89	R4-1814822				Implemented TP's from RAN4 #88bis: R4-1812544, TP for TR 38.716-02-00: CA_n1A-n79A, ZTE corporation R4-1812606, TP for TR 38.716-02-00: CA_n39A-n41A, ZTE corporation, CMCC R4-1813800, TP for TR 38.716-02-00: CA_n3A-n41A, ZTE corporation, CMCC R4-1812627, TP for TR 38.716-02-00 UE requirements for CA_n1-n77, CHTTL R4-1812298, Draft CR to TS 38.101-3: to add missing requirements for inter-band CA between FR1 and FR2, Samsung	0.2.0
2019-02	RAN4#90	R4-1900324				Implemented TP's from RAN4 #89: R4-1814650, TP for TR38.716-02-00: inter-band CA_n8-n41, CATT, CMCC R4-1814651, TP for TR38.716-02-00: inter-band CA_n41-n79, CATT, CMCC R4-1814505, TP for TR38.716-02-00: MSD requirements due to cross band isolation for 1UL/2UL for CA_n3-n41, ZTE Corporation, CMCC R4-1816215, TP for TR 38.716-02-00: MSD for CA_n1A-n77A due to the 2nd harmonic, MediaTek Inc., CHTTL	0.3.0
2019-04	RAN4#90bis	R4-1904894				Implemented TP's from RAN4 #90: R4-1900203, TP for TR 38.716-02-00: CA_n5A-n78A with 1UL and 2UL, China Telecom R4-1900204, TP for TR 38.716-02-00: CA_n5A-n79A with 1UL and 2UL, China Telecom	0.4.0

					R4-1900455, TP for TR38.716-02-00: 1UL and 2UL for CA_n40-n41, ZTE Corporation, CMCC R4-1902119, TP for TR38.716-02-00: Requirements for CA_n70A-n71A, Dish Network R4-1902133, TP to TR 38.716-02-00: CA_n50A_n78A, Huawei, Hisilicon, Etisalat R4-1902132, TP to TR 38.716-02-00: CA_n28A_n50A, Huawei, Hisilicon, Etisalat R4-1902131, TP to TR 38.716-02-00: CA_n41A_n50A, Huawei, Hisilicon, Etisalat R4-1900090, TP to TR 38.716-02-00 CA_n71-n261, Nokia, TMO US R4-1901450, TP for TR 38.716-02-00 to include CA_n71A-n260A, CA_n71A-n260(2A), Ericsson, T-Mobile US	
2019-05	RAN4#9 1	R4-1905855			Implemented TP's from RAN4 #90bis: R4-1903085, TP for TR38.716-02-00: Requirements for CA_n66B-n70A, Dish Network R4-1903086, TP for TR38.716-02-00: Requirements for CA_n66(2A)-n70A, Dish Network R4-1903087, TP for TR38.716-02-00: Requirements for CA_n66(2A)-n71A, Dish Network R4-1903422, TP for TR 38.716-02-00: CA_n1A-n78C with 1UL and 2UL, China Telecom R4-1903423, TP for TR 38.716-02-00: CA_n5A-n78C with 1UL and 2UL, China Telecom R4-1903424, TP for TR 38.716-02-00: CA_n5A-n79C with 1UL and 2UL, China Telecom R4-1903544 TP to TR 38.716-02-00: CA_n41x-n71x, Nokia, TMO US R4-1904898 TP to TR 38.716-02-00: CA_n41A_n50A, Huawei, Hisilicon, Etisalat R4-1903839 TP for TR 38.716-02-00: 1UL and 2UL for CA_n3A-n8A, ZTE Corporation R4-1904973 TP for TR 38.716-02-00: MSD for CA_n8-n41, CATT, CMCC R4-1904897 TP for TR 38.716-02-00: 2UL for CA_n8A-n79A, ZTE Corporation R4-1904435 TP for TR 38.716-02-00 to include CA_n25A-n41A, CA_n25(2A)-n41A, CA_n25A-n41C, CA_n25A-n41(2A), Ericsson, Sprint, T-Mobile US R4-1904999 TP for TR 38.716-02-00 to include CA_n25A-n71A, Ericsson, T-Mobile US R4-1904893 TP for TR 38.716-02-00: Interference analysis for CA_n39A-n79A, CATT R4-1904902 TP to TR 38.716-02-00: CA_n28A_n50A,	V0.5.0

					Huawei, Hisilicon, Etisalat R4-1904430 TP for TR 38.716-02-00 to include CA_n40-n78, Ericsson R4-1903143 TP for TR38.716-02-00: 1UL and 2UL for CA_n40-n79, ZTE Corporation, CMCC R4-1904971 TP to TR 38.716-02-00: CA_n50A_n78A, Huawei, Hisilicon, Etisalat R4-1903002 TP for TR 37.716-02-00 Introduction of CA_n41-n261, Nokia, Nokia Shanghai Bell R4-1903003 TP for TR 37.716-02-00 Introduction of CA_n25-n261, Nokia, Nokia Shanghai Bell R4-1903188 TP for TR 38.716-02-00 for CA_n77A-n258A, Huawei, Hisilicon, Etisalat R4-1903189 TP for TR 38.716-02-00 for CA_n78A-n258A, Huawei, Hisilicon, Etisalat R4-1903190 TP for TR 38.716-02-00 for CA_n79A-n258A, Huawei, Hisilicon, Etisalat R4-1903986 TP for TR 38.716-02-00: CA_n1-n257, KDDI R4-1904084 TP to TR 38.716-02-00 CA_n78A-n257G,H,I,J,K,L,M with 1UL, LG Uplus R4-1904433 TP for TR 38.716-02-00 to include CA_n41A-n260A, CA_n41A-n260(2A), Ericsson, T-Mobile US R4-1904434 TP for TR 38.716-02-00 to include CA_n25A-n260A, CA_n25A-n260(2A), Ericsson, T-Mobile US	
2019-08	RAN4#9 2	R4-1909515			Implemented TP's from RAN4 #91: R4-1905620 TP for TR38.716-02-00: 1UL and 2UL for CA_n8-n39, ZTE Corporation R4-1905792 TP for TR 38.716-02-00: CA_n28-n77, SoftBank Corp R4-1907460 TP for TR 38.716-02-00 to include CA_n3A-n8A, ZTE Corporation R4-1907405 TP for TR 38.716-02-00 to include CA_n1-n28, Ericsson, BT plc R4-1906741 TP for TR 38.716-02-00 to include CA_n3-n28, Ericsson, BT plc R4-1906742 TP for TR 38.716-02-00 to include CA_n7-n28, Ericsson, BT plc R4-1907406 TP for TR 38.716-02-00 to include CA_n20-n28, Ericsson, BT plc R4-1907399 TP to TR 38.716-02-00 CA_n78-n257 with 2UL, LG Uplus	V0.6.0
2019-10	RAN4#9 2bis	R4-1910833			Implemented TP's from RAN4 #92: R4-1910299 TP for TR 38.716-02-00: CA_n48_n66, Samsung, Verizon R4-1908930 [CA] TP for TR 38.716-02-00: adding BCS1 for relative inter-band CA, Huawei, HiSilicon R4-1910263 TP for TR 38.716-02-00: CA_n7A-n78A,	V0.7.0

					Huawei, HiSilicon R4-1910199 TP for TR 38.716-02-00: CA_n7-n66,Huawei, HiSilicon R4-1910200 TP for TR 38.716-02-00 CA_n41-n66,Nokia, Nokia Shanghai Bell, T-Mobile USA R4-1908094 TP for TR 38.716-02-00: CA_n2_n48, Samsung,Verizon R4-1908264 TP for TR 38.716-02-00: CA_n28A-n78A, KDDI R4-1908561 TP for TR38.716-02-00: 1UL and 2UL for CA_n1-n8, ZTE Corporation, R4-1908706 TP for TR38.716-02-00: Requirements for CA_n66B-n71A,Dish Network R4-1908262 TP for TR 38.716-02-00: CA_n77-n257, KDDI R4-1910209 TP for TR 38.716-02-00: CA_n3-n257, KDDI, SoftBank Corp. R4-1910210 TP for TR 38.716-02-00: CA_n28-n257, KDDI R4-1908261 TP for TR 38.716-02-00: CA_n28A-n77(2A), KDDI R4-1908096 TP to TR 38.716-02-00 CA_n5-n260 with 1UL and 2UL, Samsung,Verizon R4-1908097 TP to TR 38.716-02-00 CA_n5-n261 with 1UL and 2UL, Samsung,Verizon R4-1908263 TP for TR 38.716-02-00: CA_n77A-n261A, KDDI R4-1909256 TP for TR 38.716-02-00 CA_n41-n261 ,Nokia, Nokia Shanghai Bell, T-Mobile USA	
2019-11	RAN4#9 3	R4-1913237			Implemented TP's from RAN4 #92bis: R4-1912578, TP for TR 38.716-02-00: CA_n66A-n78A, Huawei, HiSilicon R4-1911253, TP for TR 38.716-02-00: 2UL for CA_n39A-n40A,ZTE Corporation R4-1911254, TP for TR 38.716-02-00: 2UL for CA_n3A-n40A,ZTE Corporation R4-1911255, TP for TR 38.716-02-00: 2UL for CA_n8A-n40A,ZTE Corporation R4-1911467, updated TP for TR 38.716-02-00: CA_n7A-n78A and CA_n7A-n78(2A), Huawei, HiSilicon R4-1912579,TP for TR 38.716-02-00: CA_n1A-n3A and CA_n1B-n3A, Huawei, HiSilicon, Ericsson R4-1912580, TP for TR 38.716-02-00: CA_n1-n41,Huawei, HiSilicon R4-1911470, TP for TR 38.716-02-00: CA_n28-n41,Huawei, HiSilicon R4-1912429, TP for TR 38.716-02-00: Introduction of UL CA_n25A-n41A for DL CA_n25A-n41C and DL CA_n25A-n41(2A), Sprint Corporation	V0.8.0
2020-02	RAN4#9 4-e	R4-2000803			Implemented TP's from RAN4 #93: R4-1915694, TP for TR 38.716-02-00: CA_n2A_n5A, Verizon, Nokia	V0.9.0

					R4-1914013, TP for TR 38.716-02-00 CA_n3-n77, KDDI R4-1914295, updated TP for TR 38.716-02-00: CA_n7-n78, Huawei, HiSilicon R4-1914296, updated TP for TR 38.716-02-00: CA_n1A-n3(2A), Huawei, HiSilicon R4-1914297, TP for TR 38.716-02-00: CA_n20-n78, Huawei, HiSilicon R4-1915633, TP for TR 38.716-02-00 to include CA_n1-n7, Ericsson, BT plc R4-1913837, TP for TR 38.716-02-00: CA_n5A_n260A, Verizon, Nokia R4-1913838, TP for TR 38.716-02-00: CA_n5A_n261A, Verizon, Nokia R4-1915634, TP for TR 38.716-02-00: CA_n66A_n260A, Verizon, Nokia R4-1915635, TP for TR 38.716-02-00: CA_n66A_n261A, Verizon, Nokia	
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2020-04	RAN4#9 4bis-e	R4-2003951			<p>Implemented TP's from RAN4 #94-e:</p> <ol style="list-style-type: none"> 1. R4-2002635, TP for TR38.716-02-00: Requirements for DL CA_n29A-n70A, DL CA_n29A-n66B, DL CA_n29A-n66(2A) and for UL CA_n66A-n71A, UL CA_n70A-n71A, Dish Network 2. R4-2002636, TP to TR 38.716-02-00: CA_n28-n78, Nokia, Nokia, Shanghai Bell, BT plc 3. R4-2002637, TP to TR 38.716-02-00: CA_n41-n66, Nokia, Nokia Shanghai Bell, T-Mobile USA 4. R4-2002638, TP to TR 38.716-02-00: CA_n41-n71, Nokia, Nokia Shanghai Bell, T-Mobile USA 5. R4-2000448, CR to TS 38.101-1: Corrections on MSD tables for CA_n20-n78 and CA_n66-n78, Xiaomi 6. R4-2002640, TP to TR 38.716-02-00: CA_n3A-n38A, ZTE Corporation 7. R4-2002641, TP for TR 38.716-02-00: CA_n2A_n66A, Verizon, Nokia, Qualcomm 8. R4-2002642, TP for TR 38.716-02-00: CA_n5A_n66A, Verizon, Nokia, Qualcomm 9. R4-2002643, TP for TR 38.716-02-00: CA_n2-n78, Huawei, HiSilicon 10. R4-2000833, TP for TR 38.716-02-00: CA_n7-n25, Huawei, HiSilicon 11. R4-2002714, TP for TR 38.716-02-00: CA_n25-n66, Huawei, HiSilicon 12. R4-2002645, TP to TR 38.716-02-00 for CA_n25-n78, Huawei, HiSilicon 13. R4-2002646, TP to TR 38.716-02-00 for CA_n66-n78, Huawei, HiSilicon 14. R4-2002647, TP to TR 38.716-02-00 for CA_n1-n78(2A), Huawei, HiSilicon 15. R4-2002648, TP to TR 38.716-02-00 for CA_n20A-n7A, Huawei, HiSilicon 16. R4-2001062, Draft CR for 38.101-1 to correct editorial errors, Huawei, HiSilicon 17. R4-2002639 TP to TR 38.716-02-00: Corrections to CA_n5-n261 and CA_n66-n261, Nokia, Nokia Shanghai Bell 	V1.0.0
2020-04	RAN4#9 4bis-e	R4-2005718			<p>Implemented TP's from RAN4 #94bis-e:</p> <ol style="list-style-type: none"> 1. R4-2005044, TP to TR 38.716-02-00 CA_n78A-n92A, Huawei, HiSilicon 1. R4-2005046, Updated TP for TR 38.716-02-00: to add UL configuration for CA_n41A-n78A, Huawei, HiSilicon 2. R4-2005047, TP for 38.716-02-00 for CA_n40A-n78(2A), Huawei, HiSilicon 3. R4-2005048, TP to TR 38.716-02-00 for CA_n7-n78, Huawei, HiSilicon, Bell Mobility, Telus 4. R4-2005049, TP for TR 38.716-02-00 to include CA_n41A-n71A, Ericsson, T-Mobile 5. R4-2005050, TP for TR 38.716-02-00 to include CA_n25A-n71A, Ericsson, T-Mobile 6. R4-2005051, TP for TR 38.716-02-00 to include 	V1.1.0

					CA_n41A-n66A, Ericsson, T-Mobile 7. R4-2005052, TP for TR 38.716-02-00 to include CA_n1A-n40A, Ericsson 8. R4-2005053, TP for TR 38.716-02-00 to include CA_n28A-n40A, Ericsson 9. R4-2004991, TP for TR 38.716-02-00: Requirements UL CA_n66A-n71A and corrections to UL CA_n66A-71A and UL CA_n70-n71A UE Co-existence spurious emissions 10. R4-2005054, TP for TR 38.716-02-00 to include CA_n78-n258, Ericsson, Telstra 11. R4-2005730 TP for TR 38.716-02-00 for CA_n48-n46, Charter Communications, Inc 12. R4-2005721, TP for TR 38.716-02-00 to include CA_n25A-n46A, Ericsson, T-Mobile, MediaTek 13. R4-2005722, TP for TR 38.716-02-00 to include CA_n46A-n66A, Ericsson, T-Mobile, MediaTek	
2020-05	RAN4#9 5-e	R4-2006872			Implemented TP's from RAN4 #95-e 1. R4-2006067 Corrections to n29-n66 CA combinations, Dish Network 2. R4-2008351 TP to TR 38.716-02-00 for CA_n5-n66 with dual UL, Huawei, HiSilicon, Bell Mobility, Telus 3. R4-2008352 TP for TR 38.716-02-00: CA_n2-n77, Verizon UK Ltd 4. R4-2008353 TP for TR 38.716-02-00: CA_n5-n77, Verizon UK Ltd 5. R4-2008354 TP for TR 38.716-02-00: CA_n5-n77, Verizon UK Ltd 6. R4-2008356 TP to TR 38.716-02-00 CA_n78(2A)-n92A, Huawei, HiSilicon 7. R4-2008357 TP for TR 38.716-02-00: CA_n38A-n78A, ZTE Corporation 8. R4-2007624 TP for TR 38.716-02-00 to include CA_n5-n7, Ericsson, Telstra 9. R4-2008358 TP for TR 38.716-02-00 to include CA_n3-n7, Ericsson, Telstra, BT plc 10. R4-2006481 TP for TR 38.716-02-00 for CA_n48-n46, Charter Communications, Inc 11. R4-2007918 TP for TR 38.716-02-00 to correct MSD for CA_n25-n46, Ericsson, T-Mobile US, MediaTek	v1.2.0
2020-06	RAN #88-e	RP-200671				v1.2.0

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2020-06	RAN#88					Approved by plenary – Rel-16 spec under change control	16.0.0