

ATIS 3GPP SPECIFICATION

ATIS.3GPP.37.863-01-01.V1540

3rd Generation Partnership Project;

Technical Specification Group Radio Access Network;

E-UTRA (Evolved Universal Terrestrial Radio Access) - NR Dual Connectivity (EN-DC) of LTE 1 Down Link (DL) / 1 Up Link (UL) and 1 NR band

(Release 15**)**

Approved by

WTSC

Wireless Technologies and Systems Committee

3GPP

Petitioners' Exhibit 1037
Ericsson Inc., et al. v. KT Corporation, et al.
Case No. IPR2025-00084; U.S. Patent No. 11,219,000

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6.110.2 Channel bandwidths per operating band for DC 426
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6.112.5 MSD 434
6.113 DC_66A_n5A 434
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6.113.2 Channel bandwidths per operating band for DC 434
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Foreword

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

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

Version x.y.z

where:

- x the first digit:
  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
  - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

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1 Scope

The present document is a technical report for Dual connectivity (DC) band combinations of LTE 1DL/1UL + one NR band under Rel-15 time frame. The purpose is to gather the relevant background information and studies in order to address Dual connectivity (DC) band combinations of LTE 1DL/1UL + one NR band for the Rel-15 band combinations in Table 1-1.

Table 1-1: Release 15 DC band combination of LTE 1DL/1UL + one NR band

DC combination	REL independent from	Single UL allowed (NOTE 1)
DC_1A-n77A	Rel-15	Yes
DC_1A-n78A	Rel-15	No
DC_1A-n79A	Rel-15	No
DC_3A-n77A	Rel-15	Yes
DC_3A-n78A	Rel-15	Yes
DC_3A-n79A	Rel-15	No
DC_11A-n77A		

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Rel-15

No

DC_11A-n78A

Rel-15

No

DC_11A-n79A

Rel-15

No

DC_11A-n257A

Rel-15

No

DC_18A-n77A

Rel-15

No

DC_18A-n78A

Rel-15

No

DC_18A-n79A

Rel-15

No

DC_18A-n257A

Rel-15

No

DC_19A-n77A

Rel-15

No

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DC_19A-n78A

Rel-15

No

DC_19A-n79A

Rel-15

No

DC_21A-n77A

Rel-15

No

DC_21A-n78A

Rel-15

No

DC_21A-n79A

Rel-15

No

DC_26A-n77A

Rel-15

No

DC_26A-n78A

Rel-15

No

DC_26A-n79A

Rel-15

No

DC_26A-n257A

Rel-15

No

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DC_28A-n77A

Rel-15

No

DC_28A-n78A

Rel-15

No

DC_28A-n79A

Rel-15

No

DC_41A-n257A

Rel-15

No

DC_42A-n77A

Rel-15

No

DC_42A-n78A

Rel-15

No

DC_42A-n79A

Rel-15

No

DC_20A-n28A

Rel-15

No

DC_39A-n78A

Rel-15

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No

DC_39A-n258A

Rel-15

No

DC_1A_n257

Rel-15

No

DC_3A_n257

Rel-15

No

DC_3A-n258A

Rel-15

No

DC_5A-n257A

Rel-15

No

DC_7A-n78

Rel-15

No

DC_7A-n258A

Rel-15

No

DC_8A-n78A

Rel-15

No

DC_8A-n79A

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Rel-15

No

DC_8A-n258A

Rel-15

No

DC_19A-n257

Rel-15

No

DC_20A-n78A

Rel-15

No

DC_21A-n257

Rel-15

No

DC_28A-n257

Rel-15

No

DC_28A-n258A

Rel-15

No

DC_38A-n78A

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No

DC_39A-n79A

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No

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DC_41A-n77A

Rel-15

No

DC_41A-n78A

Rel-15

No

DC_41A-n79A

Rel-15

No

DC_41A-n258A

Rel-15

No

DC_42A-n257

Rel-15

No

DC_1A-n28

Rel-15

No

DC_3A-n7

Rel-15

No

DC_3A-n28

Rel-15

No

DC_5A-n78A

Rel-15

No

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DC_7A_n28

Rel-15

No

DC_7A-n257A

Rel-15

No

DC_66A-n257A

Rel-15

No

DC_8A_n77A

Rel-15

No

DC_8A_n257A

Rel-15

No

DC_25A_n41A

Rel-15

No

DC_26A_n41A

Rel-15

No

DC_41A_n41A

Rel-15

No

DC_66A_n71A

Rel-15

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No

DC_(n)71B

Rel-15

No

DC_20A_n8A

Rel-15

No

DC_46A_n78A

Rel-15

No

DC_1A_n50A

Rel-15

No

DC_1A_n51A

Rel-15

No

DC_2A_n71A

Rel-15

No

DC_3A_n50A

Rel-15

No

DC_3A_n51A

Rel-15

No

DC_7A_n50A

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Rel-15

No

DC_7A_n51A

Rel-15

No

DC_20A_n50A

Rel-15

No

DC_20A_n51A

Rel-15

No

DC_28A_n50A

Rel-15

Yes

DC_28A_n51A

Rel-15

No

DC_42A_n50A

Rel-15

No

DC_42A_n51A

Rel-15

No

DC_66A_n260

Rel-15

No

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DC_2A_n257A

Rel-15

No

DC_13A_n257A

Rel-15

No

DC_48A_n257A

Rel-15

No

DC_5A_n260

Rel-15

No

DC_13A_n260A

Rel-15

No

DC_48A_n260A

Rel-15

No

DC_(n)41AA

Rel-15

No

DC_5A_n261

Rel-15

No

DC_66A_n261

Rel-15

No

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DC_1A_n40A

Rel-15

No

DC_2A_n66A

Rel-15

No

DC_2A_n78A

Rel-15

No

DC_2A_n260A

Rel-15

No

DC_3A_n3A(NOTE 2)

Rel-15

Yes

DC_3A_n40A

Rel-15

No

DC_5A_n40A

Rel-15

No

DC_5A_n66A

Rel-15

No

DC_8A_n40A

Rel-15

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No

DC_12A_n260A

Rel-15

No

DC_12A_n5A

Rel-15

No

DC_20A_n77A

Rel-15

No

DC_20A_n258A

Rel-15

No

DC_30A_n66A

Rel-15

No

DC_30A_n260A

Rel-15

No

DC_40A_n77A

Rel-15

No

DC_66A_n5A

Rel-15

No

DC_66A_n78A

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Rel-15

No

NOTE 1: Details on how to support it can be found in Section 5.2.

NOTE 2: only single tx switched UL mode is supported in Rel.15.

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 36.101: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception".

[3] 3GPP TS 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".

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

[5] 3GPP TS 38.101-3: "NR; User Equipment (UE) radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radiose".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

3.2 Symbols

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

$\Delta R_{IB,c}$ 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

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F_{DL_low}	The lowest frequency of the downlink operating band
F_{DL_high}	The highest frequency of the downlink operating band
F_{UL_low}	The lowest frequency of the uplink operating band
F_{UL_high}	The highest frequency of the uplink operating band

3.3 Abbreviations

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

BS	Base Station
CA	Carrier Aggregation
CA_nX-nY	Inter-band CA of component carrier(s) in one sub-block within Band X and component carrier(s) in one sub-block within Band Y where X and Y are the applicable NR operating band
CC	Component Carriers
DL	DownLink
FDD	Frequency Division Duplex
IMD	Inter-modulation
MSD	Maximum Sensitivity Deduction
NR	New RAT
SCS	Subcarrier spacing
TDD	Time Division Duplex
UE	User Equipment
UL	UpLink

4 Background

The present document is a technical report for Dual connectivity (DC) band combinations of LTE 1DL/1UL + one NR band under Rel-15 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 DC band combination of LTE 1DL/1UL + one NR band: General Part

5.1 UE RF General

5.1.1 Basic DC UE RF architectures at range 1

In a few previous RAN4 meeting, some key features in NR UE 3.5GHz were agreed to support at 3.5GHz NR new bands as below.

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- Specify both PC2 and PC3 UE for 3.5GHz NR frequency range in Rel-15
- Shall support 4Rx requirements
- UL 256QAM supporting (w/ QPSK,16QAM, 64QAM)
- Specify 2Tx (for diversity and UL-MIMO) requirements

Also, current 5G NR UE should be support some general features as below.

- Wideband operation in NR band
- NSA UE support LTE (xDL/1UL) + NR (1CC)

From the above observations, we designed a example RF architecture for NSA DC UE.

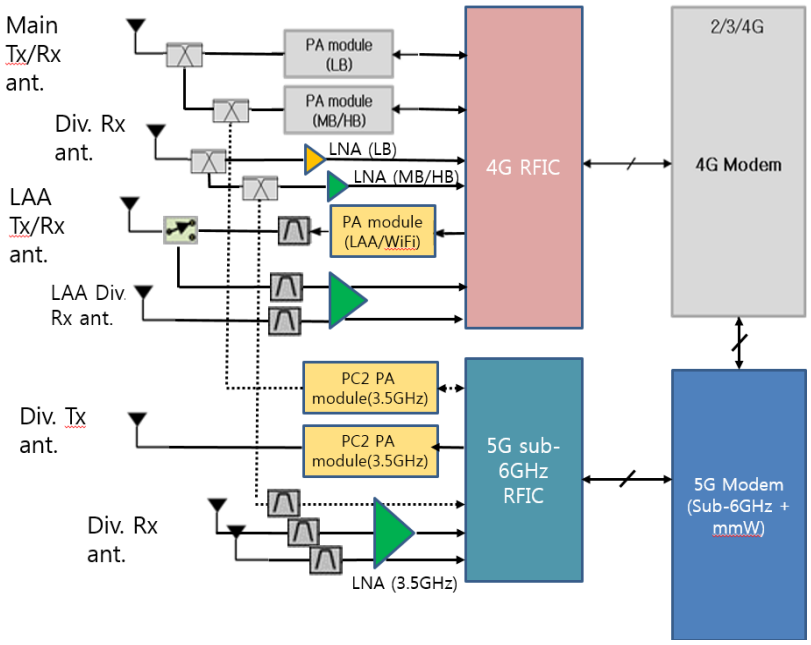


Figure 5.1.1-1. NR UE RF architecture w/ sharing antennas at Range 1

Figure 5.1.1-1 shows the common antenna sharing NR UE RF architectures for LTE and 5G NR system to support UL-MIMO and 4Rx diversity. In this figure, the main Tx/Rx antenna can use for both LTE and NR system.

The Figure 5.1.1-1 is used for NSA UE to support LTE and NR new bands except some overlapped frequency range at 3.3~4.2 GHz.

The following Figure 5.1.1-2 described the NR UE RF architecture considering separate antenna between LTE system and NR bands at sub-6GHz.

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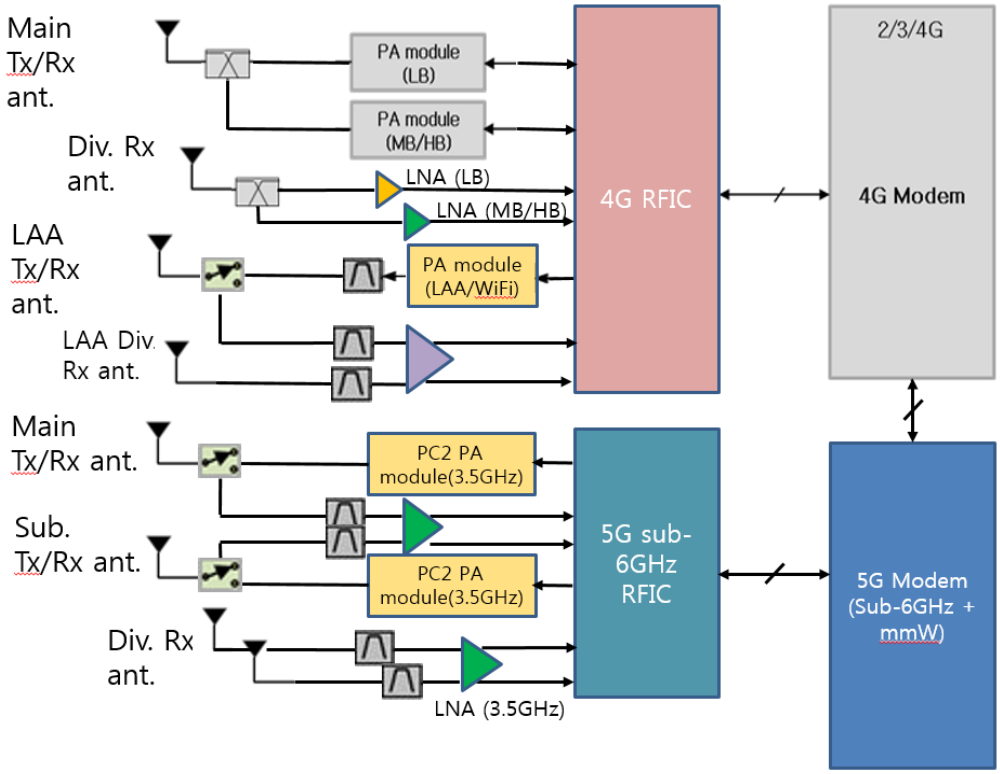


Figure 5.1.1-2. NR UE RF architecture w/ separate antennas at Range 1

The separate antenna RF architecture in figure 5.1.1-2 can be used for NR NSA UE to support LTE and 3.5GHz NR new bands since the LTE band 22, band 42 and 43 is overlapped with 3.5GHz NR new bands. In case, it is quite difficult to divide NR signal and LTE signal in UE side when we consider antenna sharing RF architecture.

Hence this architecture in Figure 5.1.1-2 also used some specific band combinations for NR DC UE.

5.1.2 Basic DC UE RF architectures at range 2

Based on the current assumptions at mmWave UE, we designed the RF architectures

- At least 4Tx antenna to guarantee spherical coverage
- Use multiple ant. elements with beamforming to get more directive gain
- Consider both single polarization and dual polarization gain
- Consider 2Rx or 4Rx diversity at mmWave

Also, current 5G NR UE should be support some general features as below.

- Wideband operation in NR band
- NSA UE support LTE (xDL/1UL) + NR (1CC)

From the above observations, we designed a example DC UE RF architecture between LTE band and NR new band at mmWave.

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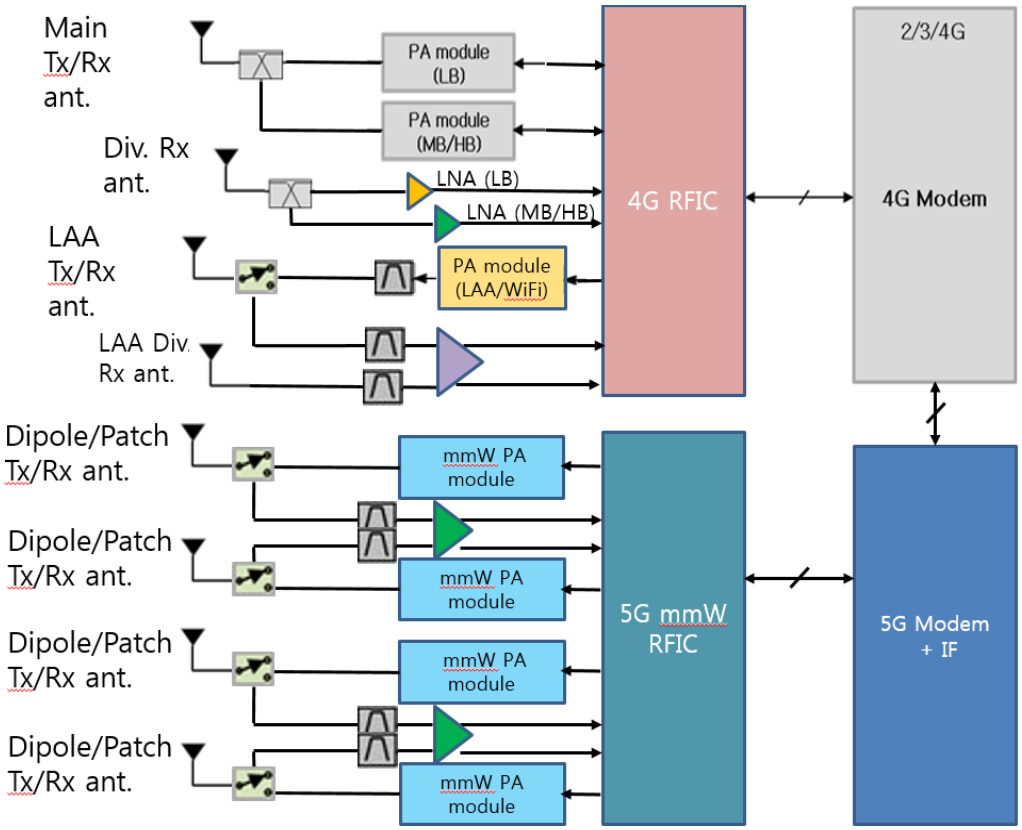


Figure 5.1.2-1. NR UE RF architecture w/ separate antennas at Range 2

Figure 5.1.2-1 shows the NR UE RF architectures with separate antenna structure for NSA DC UE between LTE bands and NR new bands at mmWave.

When NR UE support dual polarization antennas, we need twice antennas and RFIC at mmWave in a example RF architecture.

5.2 Single Tx Switched UL

In some LTE-NR inter-band combinations, as indicated in the "Difficult for simultaneous UL" column in Table 1-1, it is difficult for UE to perform simultaneous LTE+NR UL transmission. The band combinations in which the 2nd order IMD of the simultaneous UL bands fall into its own Rx band are categorized as difficult. And the band combinations for L-L (<1GHz) and H-H (1.695GHz-2.695GHz) in which the 3rd order IMD of the simultaneous UL bands fall into its own Rx band are categorized as difficult. For non-difficult band combinations, simultaneous UL transmission is mandatory.

The following formulas define which channel combinations within difficult band combinations are not affected by IM2 and IM3. Simultaneous UL transmission is mandatory for the unaffected channel combinations in difficult band combinations.

Interference bandwidth: IBW = |a| x CBW1 + |b| x CBW2

|a| + |b| = 2 (or 3)

CBW1 and CBW2 are UL channels

Center frequency of IBW: $f_{IBW} = a \times f1 + b \times f2$

f1 and f2 are center frequency of each UL channel

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The range of IMD 2 (or 3): [f_{IBW} – IBW/2, f_{IBW} + IBW/2]

Note1: The DL channel and UL channels are the transmission bandwidth, on which UE shall be able to apply operations which are configured by RRC reconfiguration and corresponding HARQ timing.

Note 2: For identified difficult band combination, during two adjacent RRC reconfiguration, the changing of transmission bandwidth should not introduce IM2 and IM3, which will result in UE changing from 2Tx to 1Tx. Otherwise, UE behavior is not specified.

For DC_3A_n3A intra-band non-contiguous EN-DC combination, only single tx switched UL mode is supported in this release.

5.3 Harmonics and IMD study

For each inter-band DC band combination, the harmonic and IMD products can be calculated by the formula shown in Table 5.3-1. For 2UL inter-band DC, up to 3rd harmonics and up to 5th IMD shall be considered in the analysis.

Table 5.3-1: Harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
Two tone 2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
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|
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|
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|
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|
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|
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|
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|
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|
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|

Instead, a concise table in Table 5.3-2 shall be provided for each DC band combination.

Table 5.3-2: Harmonics and IMD products

NR DC Configuration	E-UTRA/NR band	DL frequency range (MHz)	Rx Impact	Harmonic/IMD orders	Notes
DC_xA-nyA	x	xxxx-xxxx	Yes/No	2nd Harmonic, IMD2	
	ny	xxxx-xxxx	Yes/No	4th Harmonic, IMD4	

When 2UL inter-band EN-DC UE is operating with other systems such as Wi-Fi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems.

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Table 5.3-3: Harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Harmonic/IMD
COMPASS (Beidou)	1559	-	1591			
Galileo	1559	-	1591			
GLONASS	1591	-	1610			
GPS	1563	-	1587			
ISM band (2.4GHz)	2400	-	2483.5		US/Europe	
	2400	-	2494		Asia	
ISM band (5GHz)	5150	-	5925		US	
	5150	-	5350		Europe	
	5470	-	5725			
	5150	-	5825		Asia	

Table 5.3-4 specifies the requirements for the specified DC configurations for coexistence with protected bands.

Table 5.3-4: Spurious emissions for uplink inter-band EN-DC (two bands)

EN-DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_xA-yA	E-UTRA Band xx, yy, zz NR band aa, bb, cc	F_{DL_low}	-	F_{DL_high}	-50	1	
NOTE1: The protected E-UTRA/NR bands are the common set of the protected bands for the constituted bands.							

5.3 Minimum requirements

The following text is taken from 38.101-1 with table numbers modified. The text also has been modified by adding the a line to table 5.3-2 for -25 dBm for 1 GHz to 12.75 GHz when NS_04 is signalled for EN-DC combinaitons with n41 signalled. NS_04 signalling will only be used in the US, and in the US the spurious emission limit is -25 dBm/MHz, not -30 dBm/MHz. When NS_04 is not signalled, EN-DC combinaitons with n41will be required to meet the -30 dBm/MHz spurious emission requirement. Also, Table 5.3-1 is modified as Table 5.3-1 to be able to handle additional NR BWs.

Unless otherwise stated, the spurious emission limits apply for the frequency ranges that are more than FOOB (MHz) in Table 5.3-1 from the edge of the channel bandwidth. The spurious emission limits in Table 5.3-2 apply for all transmitter band configurations (NRB) and channel bandwidths.

NOTE: For measurement conditions at the edge of each frequency range, the lowest frequency of the measurement position in each frequency range should be set at the lowest boundary of the frequency range plus MBW/2. The highest frequency of the measurement position in each frequency range should be set at the highest boundary of the frequency range minus MBW/2. MBW denotes the measurement bandwidth defined for the protected band.

Table 5.3-1: Boundary between E-UTRA out of band and spurious emission domain

Channel bandwidth	1.4 MHz	3.0 MHz	X MHz
OOB boundary F_{OOB} (MHz)	2.8	6	X+5

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Table 5.3-2: Spurious emissions limits

Frequency Range	Maximum Level	Measurement bandwidth	NOTE
9 kHz ≤ f < 150 kHz	-36 dBm	1 kHz	
150 kHz ≤ f < 30 MHz	-36 dBm	10 kHz	
30 MHz ≤ f < 1000 MHz	-36 dBm	100 kHz	
1 GHz ≤ f < 12.75 GHz	-30 dBm	1 MHz	
1 GHz ≤ f < 12.75 GHz	-25 dBm	1 MHz	3
12.75 GHz ≤ f < 5th harmonic of the upper frequency edge of the UL operating band in GHz	-30 dBm	1 MHz	1
12.75 GHz < f < 26GHz	-30dBm	1MHz	2
NOTE 1: Applies for Band 22, Band 42, Band 43 and Band 48. NOTE 2: Applies for Band 46 and Band 47. NOTE 3: Applies for EN-DC combinations that include n41 only when NS_04 is signalled. .			

6 DC band combination of LTE 1DL/1UL + one NR band: Specific Band Combination Part

6.1 DC_1A-n77

6.1.1 Operating bands for DC

Table 6.1.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_1A-n77	1	1920 MHz – 1980 MHz	2110 MHz – 2170 MHz	FDD
	n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	TDD

6.1.2 Channel bandwidths per operating band for DC

Table 6.1.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_1A-n77A	1	15	Yes	Yes	Yes	Yes						120
	n77	15		Yes	Yes	Yes	Yes	Yes				
		30		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
		60		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
DC_1A-n77C	1	15	Yes	Yes	Yes	Yes						220
	n77	See CA_n77C in Table 5.5A.1-1 in TS 38.101-1 [3]										

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6.1.3 Co-existence studies

Table 6.1.3-1 lists Band 1 +Band n77 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.1.3-1: Band 1 and Band n77 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1920	1980	3300	4200
2nd 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
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	1320	2280	5220	6180
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)	360	660	4620	6480
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)	7140	8160	8520	10380
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)	1820	2080	3280	4220
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)	1560	2640	7920	10680
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	2640	4560		
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)	9060	10140	11820	14580
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	10440	12360		
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)	11220	14880	3480	4620
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)	5940	8760	660	2640
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)	15120	18780	10980	12120
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)	13740	16560	12360	14340

Based on Table 6.1.3-1;

- 2nd order harmonic may fall into own Rx of band n77
- 3rd order harmonic may fall into Rx frequencies of bands 46 and 47
- 2nd order IMD may also fall into own Rx of band 1and Rx frequencies of bands 2, 3, 4, 9, 10, 11, 21, 23, 24, 25, 33, 34, 35, 36, 37, 39, 45, 46, 47, 65, 66 and 70
- 3rd order IMD may also fall into Rx frequencies of bands 2, 3, 9, 22, 25, 31, 33, 34, 35, 36, 37, 39, 42, 43, 46, 47, 48, 70, n78 and n79
- 4th order IMD may also fall into own Rx of band 1 and Rx frequencies of bands 2, 3, 4, 7, 9, 10, 22, 23, 25, 30, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 48, 65, 66, 69, 70, n78 and n79

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- 5th order IMD may also fall into own Rx of band 1and Rx frequencies of bands 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 48, 65, 66, 67, 68, 69, 70, n78 and n79

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.1.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.1.3-2: 2UL Band 1 +Band n77 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD2, 4, 5
Galileo	1559	-	1591	Yes		IMD2, 4, 5
GLONASS	1591	-	1610	Yes		IMD2, 4, 5
GPS	1563	-	1587	Yes		IMD2, 4, 5
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD4, 5
	2400	-	2494	Yes	Asia	IMD4, 5
ISM band (5GHz)	5150	-	5925	Yes	US	Harmonic3, IMD2, 3
	5150	-	5350	Yes	Europe	IMD2, 3
	5470	-	5725	Yes		IMD2, 3
	5150	-	5825	Yes	Asia	Harmonic3, IMD2, 3

Table 6.1.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.1.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_1A-n77A	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	
	NR Band n257	26500	-	29500	[-5]	100	
	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

6.1.4 ΔT_{IB} and ΔR_{IB} values

Table 6.1.4-1: Simulation results provided in R4-1707507 for Band n77 and n78

Parameter	Frequency range	Vendor 1		Vendor 2		Vendor 3	
		Band n78 BPF	Band n77 BPF	Band n78 BPF	Band n77 BPF	Band n78 BPF	Band n77 BPF
Insertion loss (ETC)	3300-3400 MHz	1.1 dB	1.1 dB	2.0 dB	2.0 dB	1.9 dB	1.9 dB
	3400-3800 MHz	0.95 dB	0.95 dB	1.5 dB	1.5 dB		
	3800-4200 MHz	-	1.2 dB	-		-	
Attenuation (Typ)	698-2690 MHz	35 dB	39.8 dB	45 dB	45 dB	51.8 dB	50.5 dB
	5150-5925 MHz	27.8 dB	31.1 dB	35 dB	30 dB	25 dB	25.3 dB

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For DC_1A-n77, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.1.4-2: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_1A-n77	1	0.6
	n77	0.8
NOTE 1: HTF is assumed for Band 1.		

Table 6.1.4-3: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_1A-n77	1	0.2
	n77	0.5
NOTE 1: HTF is assumed for Band 1.		

6.1.5 MSD

Tables below list the MSD required for the dual connectivity configuration due to IMD and 2nd harmonic.

Table 6.1.5-1: MSD for the DC configuration for IMD2 and 4

E-UTRA Band / Channel bandwidth / N_{RB} / Duplex mode								Source of IMD
EUTRA/NR DC Configuration	EUTRA/NR band	UL F_c (MHz)	UL/DL BW (MHz)	UL C_{LRB}	DL F_c (MHz)	MSD (dB)	Duplex mode	
DC_1A-n77A	1	1950	5	25	2140	[29.8] [32.5[5]]	FDD	IMD2[4]
	n77	4090	10	25	4090	N/A	TDD	N/A
DC_1A-n77A	1	1950	5	25	2140	[8.0] [10.7[5]]	FDD	IMD4[4]
	n77	3710	10	25	3710	N/A	TDD	N/A
NOTE 1: Both of the transmitters shall be set min(+20 dBm, $P_{CMAX\_L,c}$) as defined in subclause 6.2.5A NOTE 2: RB_{START} = 0 NOTE : This band is subject to IMD5 also which MSD is not specified. NOTE 5: Applicable only if operation with 4 antenna ports is supported in the band with carrier aggregation configured.								

MSD values for Band n77 due to 2nd harmonic of Band 1 in LTE-NR DC_1-n77 are captured in Table 6.1.5-2.

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Table 6.1.5-2: MSD due to harmonic issue for DC_1-n77

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
1	n77[1,2]	27.1	23.9	22.1	20.9		17.9				
	n77[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.

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 $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$ 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 $2 f_{UL}^{LB}$ in the victim (higher band) with $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$, where $BW_{Channel}^{LB}$ and $BW_{Channel}^{HB}$ are the channel bandwidths configured in the aggressor (lower) and victim (higher) bands in MHz, respectively.

Regarding the uplink configuration, 40MHz for n77 should be considered additionally. Therefore, 20MHz with 100RB allocation for Band 1 should be added.

Table 6.5.5-3 Uplink configuration for the low band (exceptions) for E-UTRA

E-UTRA Band / Channel bandwidth of the high band / N_{RB} / Duplex mode									
LTE-NR DC band combination	UL band	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz	20 MHz	Duplex mode
DC_1-n77	1			12	26	39	53[1]	100[2]	FDD

NOTE 1: The configuration is used for measurement of MSD for NR channel bandwidth of 20MHz.
NOTE 2: The configuration is used for measurement of MSD for NR channel bandwidth of 40MHz.

6.1.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.1.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.1.6-1.

Table 6.1.6-1: Band 1 and Band n77 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_1A_n77A	1	a	-1	b	-1	2	1	IMD
	n77	c	1	d	0			
DC_1A_n77A	1	a	3	b	-1	4	1	IMD
	n77	c	-1	d	0			
DC_1A_n77A	1	a	-3	b	-1	5	1	IMD
	n77	c	2	d	0			
DC_1A_n77A	1	a	2	b	0	2	n77	Harmonic
	n77	c	0	d	-1			

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Equations (6.1.6.1) and (6.1.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.1.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.1.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.1.6.2)$$

Formula (3-1) and (3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.1.6.3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.1.6.3\text{-}2)$$

6.2 DC_1A-n78

6.2.1 Operating bands for DC

Table 6.2.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_1A-n78	1	1920 MHz – 1980 MHz	2110 MHz – 2170 MHz	FDD
	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD

6.2.2 Channel bandwidths per operating band for DC

Table 6.2.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_1A-n78A	1	15	Yes	Yes	Yes	Yes						120
	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	
DC_1A-n78C	1	15	Yes	Yes	Yes	Yes						220
	n78	See CA_n78C in Table 5.5A.1-1 in TS 38.101-1 [3]										

6.2.3 Co-existence studies

Table 6.2.3-1 lists Band 1 +Band n78 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.2.3-1: Band 1 and Band n78 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1920	1980	3300	3800
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3840	3960	6600	7600
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5760	5940	9900	11400
2nd 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 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)	40	660	4620	5680
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)	7140	7760	8520	9580
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)	1820	2080	3280	3820
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)	1960	2640	7920	9480
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	2640	3760		
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)	9060	9740	11820	13380
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	10440	11560		
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)	11220	13280	3880	4620
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)	5940	7560	660	1840
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)	15120	17180	10980	11720
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)	13740	15360	12360	13540

Based on Table 6.2.3-1;

- 2nd order harmonic may fall into Rx of band n77
- 3rd order harmonic may fall into Rx frequencies of bands 46 and 47
- 2nd order IMD may fall into Rx frequencies of bands 3, 9, 11, 21, 24, 32, 35, 45, 46
- 3rd order IMD may fall into Rx frequencies of bands 2, 3, 9, 22, 25, 31, 33, 34, 35, 36, 37, 39, 42, 43, 46, 48, 70, n77, n78 and n79.
- 4th order IMD may fall into Rx frequencies of bands 1, 2, 4, 7, 10, 22, 23, 25, 30, 33, 34, 36, 38, 40, 41, 42, 43, 48, 65, 66, 69, 70, n77 and n78
- 5th order IMD may also fall into own Rx of band 1and Rx frequencies of bands 3, 5, 6, 8, 11, 12, 13, 14, 17, 18, 19, 20, 21, 24, 26, 27, 28, 29, 32, 44, 45, 67, 68, n77 and n79

It should be noted that IMD will not be an issue for band n78 (no self-interference for the TDD band) even through the IMD products may fall into the concerning band. When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.2.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.2.3-2: 2UL Band 1 +Band n78 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD2, 5
Galileo	1559	-	1591	Yes		IMD2, 5
GLONASS	1591	-	1610	Yes		IMD2, 5
GPS	1563	-	1587	Yes		IMD2, 5
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD4
	2400	-	2494	Yes	Asia	IMD4
ISM band (5GHz)	5150	-	5925	Yes	US	Harmonic3, IMD2, 3
	5150	-	5350	Yes	Europe	IMD2, 3
	5470	-	5725	Yes		IMD2, 3
	5150	-	5825	Yes	Asia	Harmonic3, IMD2, 3

Table 6.2.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.2.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_1A-n78A	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	
	NR Band n257	26500	-	29500	[-5]	100	
	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

6.2.4 ΔT_{IB} and ΔR_{IB} values

For DC_1A-n78, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.2.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_1A-n78	1	0.3
	n78	0.8

Table 6.2.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_1A-n78	1	0
	n78	0.5

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6.2.5 MSD

Table 6.2.5-1 lists the MSD required for the dual connectivity configuration.

Table 6.2.5-1: MSD for the DC configuration	E-UTRA Band / Channel bandwidth / N_{RB} / Duplex mode							Source of IMD
EUTRA/NR DC Configuration	**EUTRA/NR band**	**UL F_c (MHz)**	**UL/DL BW (MHz)**	**UL C_{LRB}**	**DL F_c (MHz)**	**MSD (dB)**	**Duplex mode**	
DC_1A-n78A	1	1950	5	25	2140	8.0 10.7 [5]	FDD	IMD4[4]
	n78	3710	10	25	3710	N/A	TDD	N/A
NOTE 1: Both of the transmitters shall be set min(+20 dBm, $P_{CMAX\_L,c}$) as defined in subclause 6.2.5A NOTE 2: RB_{START} = 0 NOTE 5: Applicable only if operation with 4 antenna ports is supported in the band with carrier aggregation configured.								

6.2.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.2.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.2.6-1.

Table 6.2.6-1: Band 1 and Band n78 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_1A_n78A	1	a	3	b	-1	4	1	IMD
	n78	c	-1	d	0			

Equations (6.2.6.1) and (6.2.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.2.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (2)$$

Formula (6.2.6.3-1) and (6.2.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (3\text{-}2)$$

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6.3 DC_1A-n79

6.3.1 Operating bands for DC

Table 6.3.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band BS receive / UE transmit F_{UL_low} – F_{UL_high}	Downlink (DL) band BS transmit / UE receive F_{DL_low} – F_{DL_high}	Duplex mode
DC_1A-n79	1	1920 MHz – 1980 MHz	2110 MHz – 2170 MHz	FDD
	n79	4400 MHz – 5000 MHz	4400 MHz – 5000 MHz	TDD

6.3.2 Channel bandwidths per operating band for DC

Table 6.3.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_1A-n79A	1	15	Yes	Yes	Yes	Yes						120
	n79	15					Yes	Yes				
		30					Yes	Yes	Yes	Yes	Yes	
		60					Yes	Yes	Yes	Yes	Yes	
DC_1A-n79C	1	15	Yes	Yes	Yes	Yes						220
	n79	See CA_n79C in Table 5.5A.1-1 in TS 38.101-1 [3]										

6.3.3 Co-existence studies

Table 6.3.3-1 lists Band 1 +Band n79 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.3.3-1: Band 1 and Band n79 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1920	1980	4400	5000
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3840	3960	8800	10000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5760	5940	13200	15000
2nd 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 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)	440	1160	6820	8080
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)	8240	8960	10720	11980
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)	1820	2080	4380	5020
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_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	4840	6160		
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 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	12640	13960		
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	|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	|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_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

Based on Table 6.3.3-1;

- 2nd order harmonic may fall into Rx frequency of band n77 (3.3 – 4.2 GHz)
- 3rd order harmonic may fall into Rx frequencies of bands 46 and 47
- 2nd order IMD may also fall into Rx frequencies of bands 7, 38, 41 and 69
- 3rd order IMD may also fall into Rx frequencies of bands2, 3, 5, 6, 8, 9, 12, 13, 14, 17, 18, 19, 20, 25, 26, 27, 28, 29, 31, 33, 34, 35, 36, 37, 39, 44, 67, 68, 70
- 4th order IMD may also fall into Rx frequencies of bands 5, 6, 8, 11, 14, 18, 19, 20, 21, 24, 26, 27, 28, 44, 45, 46, 47, 68
- 5th order IMD may also fall into Rx frequencies of bands 7, 22, 41, 42, 43, 48, n77 (3.3 – 4.2 GHz) and n78 (3.3 –3.8 GHz)

When 2UL inter-band DC UE is operating with other systems such as Wi-Fi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.3.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.3.3-2: 2UL Band 1 +Band n79 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD2
	2400	-	2494	Yes	Asia	IMD2
ISM band (5GHz)	5150	-	5925	Yes	US	Harmonic3, IMD4
	5150	-	5350	Yes	Europe	IMD4
	5470	-	5725	Yes		IMD4
	5150	-	5825	Yes	Asia	Harmonic3, IMD4

Table 6.3.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.3.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_1A-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	
	NR Band n257	26500	-	29500	[-5]	100	
	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

6.3.4 ΔT_{IB} and ΔR_{IB} values

For DC_1A-n79, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.3.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_1A-n79	1	0
	n79	0

Table 6.3.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_1A-n79	1	0
	n79	0

6.3.5 MSD

There is no MSD issue for this DC configuration.

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6.4 DC_3A-n77

6.4.1 Operating bands for DC

Table 6.4.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_3A-n77	3	1710 MHz – 1785 MHz	1805 MHz – 1880 MHz	FDD
	n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	TDD

6.4.2 Channel bandwidths per operating band for DC

Table 6.4.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Config.	E-UTRA and NR 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]
DC_3A-n77A	3	15	Yes	Yes	Yes	Yes						120
	n77	15		Yes	Yes	Yes	Yes	Yes				
		30		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
		60		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
DC_3A-n77C	3	15	Yes	Yes	Yes	Yes						220
	n77	See CA_n77C in Table 5.5A.1-1 in TS 38.101-1 [3]										

6.4.3 Co-existence studies

Table 6.4.3-1 lists Band 3 +Band n77 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.4.3-1: Band 3 and Band n77 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1710	1785	3300	4200
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3420	3570	6600	8400
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5130	5355	9900	12600
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	1515	2490	5010	5985
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)	270	780	4815	6690
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)	6720	7770	8310	10185
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)	1610	1885	3280	4220
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)	930	2055	8115	10890
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	3030	4980		
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)	8430	9555	11610	14385
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	10020	11970		
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)	11415	15090	2640	3840
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)	6330	9180	1245	3270
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)	14910	18585	10140	11340
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)	13320	16170	11730	13755

Based on Table 6.4.3-1;

- 2nd order harmonic may fall into Rx frequencies of bands 22, 42, 48, n77 and n78
- 3rd order harmonic may fall into Rx frequencies of band 46

2nd order IMD may also fall into own Rx of band 3 Rx frequencies of bands 1, 2, 4, 9, 10, 23, 24, 25, 30, 33, 34, 35, 36, 37, 39, 40, 46, 47, 65, 66 and 70

3rd order IMD may also fall into own Rx of band 3 and Rx frequencies of bands 9, 12, 13, 14, 17, 22, 28, 29, 31, 35, 39, 42, 43, 44, 46, 47, 48, 67, 68, n78 and n79

4th order IMD may also fall into own Rx of band 3 and Rx frequencies of bands 2, 8, 9, 11, 10, 21, 22, 24, 25, 33, 34, 35, 36, 37, 39, 42, 43, 45, 48, 70, n78 and n79

5th order IMD may also fall into own Rx of band 3 and Rx frequencies of bands 1, 2, 4, 7, 9, 10, 11, 21, 22, 23, 24, 25, 30, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 45, 48, 65, 66, 69, 70 and n78

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.4.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.4.3-2: 2UL Band 3 +Band n77 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD2, 4, 5
Galileo	1559	-	1591	Yes		IMD2, 4, 5
GLONASS	1591	-	1610	Yes		IMD2, 4, 5
GPS	1563	-	1587	Yes		IMD2, 4, 5
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD2, 5
	2400	-	2494	Yes	Asia	IMD2, 5
ISM band (5GHz)	5150	-	5925	Yes	US	Harmonic3, IMD2, 3
	5150	-	5350	Yes	Europe	Harmonic3, IMD2, 3
	5470	-	5725	Yes		IMD2, 3
	5150	-	5825	Yes	Asia	Harmonic3, IMD2, 3

Table 6.4.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.4.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_3A-n77A	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	PHS
	NR Band n257	26500	-	29500	[-5]	100	

6.4.4 ΔT_{IB} and ΔR_{IB} values

For DC_3A-n77, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.4.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_3A-n77	3	0.6
	n77	0.8
NOTE 1: HTF is assumed for Band 3.		

Table 6.4.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_3A-n77	3	0.2
	n77	0.5
NOTE 1: HTF is assumed for Band 3.		

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6.4.5 MSD

Tables below list the MSD required for the dual connectivity configuration due to IMD and 2nd harmonic.

Table 6.4.5-1: MSD for the DC configuration for IMD2 and 4

E-UTRA Band / Channel bandwidth / N_{RB} / Duplex mode								Source of IMD
EUTRA/NR DC Configuration	EUTRA/NR band	UL F_c (MHz)	UL/DL BW (MHz)	UL C_{LRB}	DL F_c (MHz)	MSD (dB)	Duplex mode	
DC_3A-n77A	3	1740	5	25	1835	[26] [28.7 [5]]	FDD	IMD2[4]
	n77	3575	10	25	3575	N/A	TDD	N/A
DC_3A-n77A	3	1765	5	25	1860	[8.0] [10.7[5]]	FDD	IMD4[4]
	n77	3435	10	25	3435	N/A	TDD	N/A
NOTE 1: Both of the transmitters shall be set min(+20 dBm, $P_{CMAX\_L,c}$) as defined in subclause 6.2.5A NOTE 2: RB_{START} = 0 NOTE4: This band is subject to IMD5 also which MSD is not specified. NOTE 5: Applicable only if operation with 4 antenna ports is supported in the band with carrier aggregation configured.								

MSD values for Band n77 due to 2nd harmonic of Band 3 in LTE-NR DC_3-n77 are captured in Table 6.4.5-2.

Table 6.4.5-2: MSD due to harmonic issue for DC_3-n77

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
3	n77[1,2]	27.1	23.9	22.1	20.9		17.9				
	n77[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. 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 $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$ 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 $2 f_{UL}^{LB}$ in the victim (higher band) with $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$, where $BW_{Channel}^{LB}$ and $BW_{Channel}^{HB}$ are the channel bandwidths configured in the aggressor (lower) and victim (higher) bands in MHz, respectively.											

Regarding the uplink configuration, 40MHz for n77 should be considered additionally. Therefore, 20MHz with 100RB allocation for Band 3 should be added.

Table 6.5.5-3 Uplink configuration for the low band (exceptions) for E-UTRA

E-UTRA Band / Channel bandwidth of the high band / N_{RB} / Duplex mode									
LTE-NR DC band combination	UL band	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz	20 MHz	Duplex mode
DC_3-n77	3			12	26	39	53[1]	100[2]	FDD
NOTE 1: The configuration is used for measurement of MSD for NR channel bandwidth of 20MHz. NOTE 2: The configuration is used for measurement of MSD for NR channel bandwidth of 40MHz.									

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6.4.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.4.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.4.6-1.

Table 6.4.6-1: Band 3 and Band n77 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_3A_n77A	3	a	-1	b	-1	2	3	IMD
	n77	c	1	d	0			
DC_3A_n77A	3	a	3	b	-1	4	3	IMD
	n77	c	-1	d	0			
DC_3A_n77A	3	a	-3	b	-1	5	3	IMD
	n77	c	2	d	0			
DC_3A_n77A	3	a	2	b	0	2	n77	Harmonic
	n77	c	0	d	-1			

Equations (6.4.6.1) and (6.4.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.4.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.4.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.4.6.2)$$

Formula (6.4.6.3-1) and (6.4.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.4.6.3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.4.6.3\text{-}2)$$

6.5 DC_3A-n78

6.5.1 Operating bands for DC

Table 6.5.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_3A-n78	3	1710 MHz – 1785 MHz	1805 MHz – 1880 MHz	FDD
	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD

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6.5.2 Channel bandwidths per operating band for DC

Table 6.5.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Config.	**E-UTRA and NR Band**	**Subcarrier spacing [kHz]**	**1.4 MHz**	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**40 MHz**	**50 MHz**	**[60 MHz]**	**80 MHz**	**100 MHz**	**Maximum aggregated bandwidth [MHz]**
DC_3A-n78A	3	15	Yes	Yes	Yes	Yes	Yes	Yes						120
	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	
DC_3A-n78C	3	15	Yes	Yes	Yes	Yes								220
	n78	See CA_n78C in Table 5.5A.1-1 in TS 38.101-1 [3]												

6.5.3 Co-existence studies

Table 6.5.3-1 lists Band 3 +Band n78 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.5.3-1: Band 3 and Band n78 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1710	1785	3300	3800
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3420	3570	6600	7600
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5130	5355	9900	11400
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	1515	2090	5010	5585
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)	270	380	4815	5890
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)	6720	7370	8310	9385
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)	1610	1885	3280	3820
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)	1330	2055	8115	9690
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	3030	4180		
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)	8430	9155	11610	13185
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	10020	11170		
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)	11415	13490	3040	3840
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)	6330	7980	1245	2470
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)	14910	16985	10140	10940
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)	13320	14970	11730	12955

Based on Table 6.5.3-1;

2nd order harmonic may fall into Rx frequencies of bands 22, 42, 48, n77 and n78

3rd order harmonic may fall into Rx frequencies of band 46

2nd order IMD may fall into Rx frequencies of bands 2, 3, 9, 24, 25, 33, 34, 35, 36, 37, 39, 46, and 70

3rd order IMD may fall into Rx frequencies of bands 3, 9, 22, 35, 39, 42, 43, 48, n77, n78 and n79

4th order IMD may fall into Rx frequencies of bands 2, 3, 9, 11, 21, 22, 24, 25, 32, 33, 34, 35, 36, 37, 39, 42, 43, 45, 48, 70, n77 and n78

5th order IMD may fall into Rx frequencies of bands 1, 2, 3, 4, 9, 10, 11, 21, 22, 23, 24, 25, 30, 32, 33, 34, 35, 36, 37, 39, 40, 42, 43, 45, 48, 65, 66, 70, n77 and n78.

It should be noted that IMD will not be an issue for band n78 (no self-interference for the TDD band) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.5.3-2 lists if up to 3rd order

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harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.5.3-2: 2UL Band 3 +Band 77n harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD2, 4, 5
Galileo	1559	-	1591	Yes		IMD2, 4, 5
GLONASS	1591	-	1610	Yes		IMD2, 4, 5
GPS	1563	-	1587	Yes		IMD2, 4, 5
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD5
	2400	-	2494	Yes	Asia	IMD5
ISM band (5GHz)	5150	-	5925	Yes	US	Harmonic3, IMD2, 3
	5150	-	5350	Yes	Europe	Harmonic3, IMD2, 3
	5470	-	5725	Yes		IMD2, 3
	5150	-	5825	Yes	Asia	Harmonic3, IMD2, 3

Table 6.5.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.5.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_3A-n78A	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	PHS
	NR Band n257	26500	-	29500	[-5]	100	

6.5.4 ΔTIB and ΔRIB values

For DC_3A-n78, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.5.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_3A-n78	3	0.6
	n78	0.8
NOTE 1: HTF is assumed for Band 3.		

Table 6.5.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_3A-n78	3	0.2
	n78	0.5
NOTE 1: HTF is assumed for Band 3.		

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6.5.5 MSD

Tables below lists the MSD required for the dual connectivity configuration due to IMD and 2nd harmonic.

Table 6.5.5-2: MSD for the DC configuration for IMD2 and 4

E-UTRA Band / Channel bandwidth / N_{RB} / Duplex mode								Source of IMD
EUTRA/NR DC Configuration	**EUTRA/NR band**	**UL F_c (MHz)**	**UL/DL BW (MHz)**	**UL C_{LRB}**	**DL F_c (MHz)**	**MSD (dB)**	**Duplex mode**	
DC_3A-n78A	3	1740	5	25	1835	26 28.7[5]	FDD	IMD2[4]
	n78	3575	10	25	3575	N/A	TDD	N/A
	n78	3710	10	25	3710	N/A	TDD	N/A
DC_3A-n78A	3	1765	5	25	1860	8.0 10.7[5]	FDD	IMD4[4]
	n78	3435	10	25	3435	N/A	TDD	N/A
NOTE 1: Both of the transmitters shall be set min(+20 dBm, $P_{CMAX\_L,c}$) as defined in subclause 6.2.5A NOTE 2: RB_{START} = 0 NOTE4: This band is subject to IMD5 also which MSD is not specified. NOTE 5: Applicable only if operation with 4 antenna ports is supported in the band with carrier aggregation configured.								

MSD values for Band n78 due to 2nd harmonic of Band 3 in LTE-NR DC_3-n78 are captured in Table 6.5.5-5.

Table 6.5.5-2: MSD due to harmonic issue for DC_3-n78

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**
3	n78[1,2]	27.1	23.9	22.1	20.9		17.9				
	n78[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. 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 $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$ 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 $2 f_{UL}^{LB}$ in the victim (higher band) with $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$, where $BW_{Channel}^{LB}$ and $BW_{Channel}^{HB}$ are the channel bandwidths configured in the aggressor (lower) and victim (higher) bands in MHz, respectively.											

Regarding the uplink configuration, 40MHz for n78 should be considered additionally. Therefore, 20MHz with 100RB allocation for Band 3 should be added.

Table 6.5.5-3 Uplink configuration for the low band (exceptions) for E-UTRA

E-UTRA Band / Channel bandwidth of the high band / N_{RB} / Duplex mode									
LTE-NR DC band combination	**UL band**	**1.4 MHz**	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**20 MHz**	**Duplex mode**
DC_3-n78	3			12	26	39	53[1]	100[2]	FDD
NOTE 1: The configuration is used for measurement of MSD for NR channel bandwidth of 20MHz. NOTE 2: The configuration is used for measurement of MSD for NR channel bandwidth of 40MHz.									

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6.5.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.5.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.5.6-1.

Table 6.5.6-1: Band 3 and Band n78 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_3A_n78A	3	a	-1	b	-1	2	3	IMD
	n78	c	1	d	0			
DC_3A_n78A	3	a	3	b	-1	4	3	IMD
	n78	c	-1	d	0			
DC_3A_n78A	3	a	-3	b	-1	5	3	IMD
	n78	c	2	d	0			
DC_3A_n78A	3	a	2	b	0	2	n78	Harmonic
	n78	c	0	d	-1			

Equations (6.5.6.1) and (6.5.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.5.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.5.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.5.6.2)$$

Formula (6.5.6.3-1) and (6.5.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.5.6.3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.5.6.3\text{-}2)$$

6.6 DC_3A-n79

6.6.1 Operating bands for DC

Table 6.6.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_3A-n79	3	1710 MHz – 1785 MHz	1805 MHz – 1880 MHz	FDD
	n79	4400 MHz – 5000 MHz	4400 MHz – 5000 MHz	TDD

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6.6.2 Channel bandwidths per operating band for DC

Table 6.6.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	**E-UTRA and NR 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]**
DC_3A-n79A	3	15	Yes	Yes	Yes	Yes						120
	n79	15					Yes	Yes				
		30					Yes	Yes	Yes	Yes	Yes	
		60					Yes	Yes	Yes	Yes	Yes	
DC_3A-n79C	3	15	Yes	Yes	Yes	Yes						220
	n79	See CA_n79C in Table 5.5A.1-1 in TS 38.101-1 [3]										

6.6.3 Co-existence studies

Table 6.6.3-1 lists Band 3 +Band n79 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.6.3-1: Band 3 and Band n79 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1710	1785	4400	5000
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3420	3570	8800	10000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5130	5355	13200	15000
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	2615	3290	6110	6785
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)	830	1580	7015	8290
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)	7820	8570	10510	11785
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)	1610	1885	4380	5020
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)	130	955	11415	13290
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	5230	6580		
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)	9530	10355	14910	16785
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	12220	13570		
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)	15815	18290	1840	2740
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)	9630	11580	3445	4870
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)	19310	21785	11240	12140
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)	16620	18570	13930	15355

Based on Table 6.6.3-1;

2nd order harmonic may fall into Rx frequency of bands 22, 42, 48, n77 (3.3 – 4.2 GHz) and n78 (3.3 – 3.8 GHz)

3rd order harmonic may fall into Rx frequencies of bands 46

2nd order IMD may also fall into Rx frequencies of bands 7, 38, 41 and 69

3rd order IMD may also fall into own Rx of band 3 and Rx frequencies of bands 5, 6, 8, 9, 11, 18, 19, 21, 24, 26, 27, 35, 39, 45

4th order IMD may also fall into Rx frequencies of bands 5, 6, 8, 12, 13, 14, 17, 18, 19, 20, 26, 27, 28, 29, 31, 44, 46, 47, 67, 68

5th order IMD may also fall into own Rx of band 3 and Rx frequencies of bands 1, 2, 4, 7, 9, 10, 22, 23, 25, 30, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 48, 65, 66, 69, 70 and n77 (3.3 – 4.2 GHz)

When 2UL inter-band DC UE is operating with other systems such as Wi-Fi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.6.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.6.3-2: 2UL Band 3 +Band n79 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD3
Galileo	1559	-	1591	Yes		IMD3
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	Yes		IMD3
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD5
	2400	-	2494	Yes	Asia	IMD5
ISM band (5GHz)	5150	-	5925	Yes	US	Harmonic3, IMD4
	5150	-	5350	Yes	Europe	Harmonic3, IMD4
	5470	-	5725	Yes		IMD4
	5150	-	5825	Yes	Asia	Harmonic3, IMD4

Table 6.6.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.6.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_3A-n79A	E-UTRA Band 1, 3, 5, 8, 11, 18, 19, 21, 28, 34, 39, 40, 41, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 42	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	NR Band n257	26500	-	29500	[-5]	100	

6.6.4 ΔT_{IB} and ΔR_{IB} values

For DC_3A-n79, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.6.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_3A-n79	3	0
	n79	0

Table 6.6.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_3A-n79	3	0
	n79	0

6.6.5 MSD

There is no MSD issue for this DC configuration.

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6.7 DC_11A-n77A

6.7.1 Operating bands for DC

Table 6.7.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_11A-n77A	11	1427.9 MHz – 1447.9 MHz	1475.9 MHz – 1495.9 MHz	FDD
	n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	TDD

6.7.2 Channel bandwidths per operating band for DC

Table 6.7.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_11A-n77A	11	15	Yes	Yes								110
	n77	15		Yes	Yes	Yes	Yes	Yes				
		30		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
		60		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

6.7.3 Co-existence studies

Table 6.7.3-1 lists Band11+3.3-4.2GHz 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.7.3-1: Band 11 and Band n77 UL harmonics and IMD products

UE UL carriers	Fx_low	Fx_high	Fy_low	Fy_high
UL frequency (MHz)	1427.9	1447.9	3300	4200
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	2855.8	2895.8	6600	8400
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	4283.7	4343.7	9900	12600
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	1852.1	2772.1	4727.9	5647.9
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)	1344.2	404.2	5152.1	6972.1
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)	6155.8	7095.8	8027.9	9847.9
Two-tone 3rd order IMD products (with maximum channel bandwidth)	|fx_low – fy_BWmax|	|fx_high + fy_BW max|	|fy_low – fx_BW max|	|fy_high + fx_BW max|
IMD frequency limits (MHz)	1327.9	1547.9	3280	4220
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)	83.7	1043.7	8452.1	11172.1

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Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	3704.2	5544.2		
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)	7583.7	8543.7	11327.9	14047.9
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	9455.8	11295.8		
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)	15372.1	11752.1	2491.6	1511.6
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)	9744.2	7004.2	2256.3	4116.3
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)	14627.9	18247.9	9011.6	9991.6
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)	12755.8	15495.8	10883.7	12743.7

Based on the table, 3rd order IMD may fall into own Rx of band 11 and 3rd, 4th and 5th order IMD may fall into own Rx of NR band.

It should be noted that IMD will not be an issue for NR band (no self-interference) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.7.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.7.3-2: Band 11 and Band n77 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	YES		IMD5
Galileo	1559	-	1591	YES		IMD5
GLONASS	1591	-	1610	YES		IMD5
GPS	1563	-	1587	YES		IMD5
ISM band (2.4GHz)	2400	-	2483.5	YES	US/Europe	IMD5
	2400	-	2494	YES	Asia	IMD5
ISM band (5GHz)	5150	-	5925	YES	US	IMD2, IMD3, IMD4
	5150	-	5350	YES	Europe	IMD2, IMD3, IMD4
	5470	-	5725	YES		IMD2, IMD3, IMD4
	5150	-	5825	YES	Asia	IMD2, IMD3, IMD4

Table 6.7.3-3 lists the protected bands required for the dual connectivity configuration.

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Table 6.7.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_11A-n77A	E-UTRA Band 1, 3, 18, 19, 28, 34, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	
	NR Band n257	26500	-	29500	[-5]	100	

6.7.4 ΔTIB and ΔRIB values

For DC_11A-n77A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.7.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_11A-n77A	11	0.4
	n77	0.8

Table 6.7.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_11A-n77A	11	0
	n77	0.5

6.7.5 MSD

As approved in R4-1710977, no MSD due to IMD and harmonic should be specified in this combination and MSD requirement is shown in table 6.7.5-1.

Table 6.7.5-1: MSD requirement for dual uplink DC_11A-n77A

E-UTRA+NR Band / Channel bandwidth / N_{RB} / Duplex mode							
EUTRA CA Configuration	EUTRA+NR band	UL F_c (MHz)	UL/DL BW (MHz)	UL C_{LRB}	DL F_c (MHz)	MSD (dB)	Duplex mode
DC_11A-n77A	11	N/A	N/A	N/A	N/A	N/A	FDD
	n77	N/A	N/A	N/A	N/A	N/A	TDD

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6.8 DC_11A-n78A

6.8.1 Operating bands for DC

Table 6.8.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_11A-n78A	11	1427.9 MHz – 1447.9 MHz	1475.9 MHz – 1495.9 MHz	FDD
	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD

6.8.2 Channel bandwidths per operating band for DC

Table 6.8.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_11A-n78A	11	1427.9 MHz – 1447.9 MHz	1475.9 MHz – 1495.9 MHz	FDD
	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD

6.8.3 Co-existence studies

Table 6.8.3-1 lists Band11+3.3-3.8GHz 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.8.3-1: Band 11 and Band n78 UL harmonics and IMD products

UE UL carriers	Fx_low	Fx_high	Fy_low	Fy_high
UL frequency (MHz)	1427.9	1447.9	3300	3800
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	2855.8	2895.8	6600	7600
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	4283.7	4343.7	9900	11400
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	1852.1	2372.1	4727.9	5247.9
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)	944.2	404.2	5152.1	6172.1
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)	6155.8	6695.8	8027.9	9047.9
Two-tone 3rd order IMD products (with maximum channel bandwidth)	|fx_low – fy_BWmax|	|fx_high + fy_BW max|	|fy_low – fx_BW max|	|fy_high + fx_BW max|
IMD frequency limits (MHz)	1327.9	1547.9	3280	3820
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)	483.7	1043.7	8452.1	9972.1
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	3704.2	4744.2		
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)	7583.7	8143.7	11327.9	12847.9
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	9455.8	10495.8		
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)	13772.1	11752.1	2491.6	1911.6
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)	8544.2	7004.2	2256.3	3316.3
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)	14627.9	16647.9	9011.6	9591.6
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)	12755.8	14295.8	10883.7	11943.7

Based on the table, 3rd order IMD may fall into own Rx of band 11, and 3rd, 4th and 5th order IMD may fall into own Rx of NR band.

It should be noted that IMD will not be an issue for NR band (no self-interference) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.8.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.8.3-2: Band 11 and Band n78 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591			
Galileo	1559	-	1591			
GLONASS	1591	-	1610			
GPS	1563	-	1587			
ISM band (2.4GHz)	2400	-	2483.5		US/Europe	
	2400	-	2494		Asia	
ISM band (5GHz)	5150	-	5925	YES	US	IMD2, IMD3
	5150	-	5350	YES	Europe	IMD2, IMD3
	5470	-	5725	YES		IMD3
	5150	-	5825	YES	Asia	IMD2, IMD3

Table 6.8.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.8.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_11A-n78A	E-UTRA Band 1, 3, 18, 19, 28, 34, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	
	NR Band n257	26500	-	29500	[-5]	100	

6.8.4 ΔTIB and ΔRIB values

For DC_11A-n78A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.8.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_11A-n78A	11	0.4
	n78	0.8

Table 6.8.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_11A-n78A	11	0
	n78	0.5

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6.8.5 MSD

As approved in R4-1710977, no MSD due to IMD and harmonic should be specified in this combination and MSD requirement is shown in table 6.8.5-1.

Table 6.8.5-1: MSD requirement for dual uplink DC_11A-n78A

E-UTRA+NR Band / Channel bandwidth / N_{RB} / Duplex mode							
EUTRA CA Configuration	**EUTRA+NR band**	**UL F_c (MHz)**	**UL/DL BW (MHz)**	**UL C_{LRB}**	**DL F_c (MHz)**	**MSD (dB)**	**Duplex mode**
DC_11A-n78A	11	N/A	N/A	N/A	N/A	N/A	FDD
	n78	N/A	N/A	N/A	N/A	N/A	TDD

6.9 DC_11A-n79A

6.9.1 Operating bands for DC

Table 6.9.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_11A-n79A	11	1427.9 MHz – 1447.9 MHz	1475.9 MHz – 1495.9 MHz	FDD
	n79	4400 MHz – 5000 MHz	4400 MHz – 5000 MHz	TDD

6.9.2 Channel bandwidths per operating band for DC

Table 6.9.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	**E-UTRA and NR 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]**
DC_11A-n79A	11	15	Yes	Yes								110
	n79	15					Yes	Yes				
		30					Yes	Yes	Yes	Yes	Yes	
		60					Yes	Yes	Yes	Yes	Yes	

6.9.3 Co-existence studies

Table 6.9.3-1 lists Band11+4.4-5GHz 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.9.3-1: Band 11 and Band n79 UL harmonics and IMD products

UE UL carriers	Fx_low	Fx_high	Fy_low	Fy_high
UL frequency (MHz)	1427.9	1447.9	4400	5000
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	2855.8	2895.8	8800	10000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	4283.7	4343.7	13200	15000
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	2952.1	3572.1	5827.9	6447.9
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)	2144.2	1504.2	7352.1	8572.1
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)	7255.8	7895.8	10227.9	11447.9
Two-tone 3rd order IMD products (with maximum channel bandwidth)	|f1_low – f2_BWmax|	|f1_high + f2_BW max|	|f2_low – f1_BW max|	|f2_high + f1_BW max|
IMD frequency limits (MHz)	1327.9	1547.9	4380	5020
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)	716.3	56.3	11752.1	13572.1
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	5904.2	7144.2		
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)	8683.7	9343.7	14627.9	16447.9
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	11655.8	12895.8		
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)	18572.1	16152.1	1391.6	711.6
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)	12144.2	10304.2	4456.3	5716.3
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)	19027.9	21447.9	10111.6	10791.6
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)	16055.8	17895.8	13083.7	14343.7

Based on the table, 3rd order IMD may fall into own Rx of band 11, and 3rd and 5th order IMD may fall into own Rx of NR band.

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It should be noted that IMD will not be an issue for NR band (no self-interference) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.9.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.9.3-2: Band 11 and Band n79 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	YES		IMD3
Galileo	1559	-	1591	YES		IMD3
GLONASS	1591	-	1610	YES		IMD3
GPS	1563	-	1587	YES		IMD3
ISM band (2.4GHz)	2400	-	2483.5		US/Europe	
	2400	-	2494		Asia	
ISM band (5GHz)	5150	-	5925	YES	US	IMD4, IMD5
	5150	-	5350	YES	Europe	IMD5
	5470	-	5725	YES		IMD5
	5150	-	5825	YES	Asia	IMD5

Table 6.9.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.9.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_11A-n79A	E-UTRA Band 1, 3, 18, 19, 28, 34, 42, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	
	NR Band n257	26500	-	29500	[-5]	100	

6.9.4 ΔTIB and ΔRIB values

For DC_11A-n79A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.9.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_11A-n79A	11	0
	n79	0

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Table 6.9.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_11A-n79A	11	0
	n79	0

6.9.5 MSD

As approved in R4-1710977, no MSD due to IMD and harmonic should be specified in this combination and MSD requirement is shown in table 6.9.5-1.

Table 6.9.5-1: MSD requirement for dual uplink DC_11A-n79A

E-UTRA+NR Band / Channel bandwidth / N_{RB} / Duplex mode							
EUTRA CA Configuration	EUTRA+NR band	UL F_c (MHz)	UL/DL BW (MHz)	UL C_{LRB}	DL F_c (MHz)	MSD (dB)	Duplex mode
DC_11A-n79A	11	N/A	N/A	N/A	N/A	N/A	FDD
	n79	N/A	N/A	N/A	N/A	N/A	TDD

6.9.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.9.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.9.6-1.

Table 6.9.6-1: Band 11 and Band n79 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_11A_n79A	11	a	0	b	3	3	11	Harmonic mixing
	n79	c	-1	d	0			

Equations (6.9.6.1) and (6.9.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.9.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.9.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.9.6.2)$$

Formula (6.9.6.3-1) and (6.9.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.9.6.3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.9.6.3\text{-}2)$$

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6.10 DC_11A-n257A

6.10.1 Operating bands for DC

Table 6.10.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_11A_n257	11	1427.9 MHz – 1447.9 MHz	1475.9 MHz – 1495.9 MHz	FDD
	n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD

6.10.2 Channel bandwidths per operating band for DC

Table 6.10.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	[50 MHz]	100 MHz	200 MHz	400 MHz	Maximum aggregated bandwidth [MHz]
DC_11A_n257	11	15	Yes	Yes							410
	n257	60					Yes	Yes	Yes		
		120					Yes	Yes	Yes	Yes	

6.10.3 Co-existence studies

Table 6.10.3-1 lists Band11+26.5-29.5GHz 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.10.3-1: Band 11 and Band n257 UL harmonics and IMD products

UE UL carriers	Fx_low	Fx_high	Fy_low	Fy_high
UL frequency (MHz)	1427.9	1447.9	26500	29500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	2855.8	2895.8	53000	59000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	4283.7	4343.7	79500	88500
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	25052.1	28072.1	27927.9	30947.9
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)	26644.2	23604.2	51552.1	57572.1
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)	29355.8	32395.8	54427.9	60447.9
Two-tone 3rd order IMD products (with maximum channel bandwidth)	|fx_low – fy_BWmax|	|fx_high + fy_BW max|	|fy_low – fx_BW max|	|fy_high + fx_BW max|
IMD frequency limits (MHz)	1027.9	1847.9	26480	29520
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)	25216.3	22156.3	78052.1	87072.1
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	50104.2	56144.2		
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)	30783.7	33843.7	80927.9	89947.9
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	55855.8	61895.8		
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)	116572.1	104552.1	20708.4	23788.4
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)	85644.2	76604.2	48656.3	54716.3
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)	107427.9	119447.9	32211.6	35291.6
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)	82355.8	91395.8	57283.7	63343.7

Based on the table, 3rd order IMD may fall into own Rx of band 11, and 2nd and 3rd order IMD may fall into own Rx of NR band.

It should be noted that IMD will not be an issue for NR band (no self-interference) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.10.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.10.3-2: Band 11 and Band n257 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	YES		IMD3
Galileo	1559	-	1591	YES		IMD3
GLONASS	1591	-	1610	YES		IMD3
GPS	1563	-	1587	YES		IMD3
ISM band (2.4GHz)	2400	-	2483.5		US/Europe	
	2400	-	2494		Asia	
ISM band (5GHz)	5150	-	5925		US	
	5150	-	5350		Europe	
	5470	-	5725			
	5150	-	5825		Asia	

Table 6.10.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.10.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_11A-n257A	E-UTRA Band 1, 3, 18, 19, 28, 34, 42, 65, n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	

6.10.4 ΔTIB and ΔRIB values

For DC_11A_n257, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.10.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_11A_n257	11	0
	n257	0

Table 6.10.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_11A_n257	11	0
	n257	0

6.10.5 MSD

As approved in R4-1710977, no MSD due to IMD and harmonic should be specified in this combination and MSD requirement is shown in table 6.10.5-1.

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Table 6.10.5-1: MSD requirement for dual uplink DC_11A-n257A

E-UTRA+NR Band / Channel bandwidth / N_{RB} / Duplex mode							
EUTRA CA Configuration	**EUTRA+NR band**	**UL F_c (MHz)**	**UL/DL BW (MHz)**	**UL C_{LRB}**	**DL F_c (MHz)**	**MSD (dB)**	**Duplex mode**
DC_11A-n257A	11	N/A	N/A	N/A	N/A	N/A	FDD
	N257	N/A	N/A	N/A	N/A	N/A	TDD

6.11 DC_18A-n77A

6.11.1 Operating bands for DC

Table 6.11.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_18A-n77A	18	815 MHz – 830 MHz	860 MHz – 875 MHz	FDD
	n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	TDD

6.11.2 Channel bandwidths per operating band for DC

Table 6.11.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	**E-UTRA and NR 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]**
DC_18A-n77A	18	15	Yes	Yes	Yes							115
	n77	15		Yes	Yes	Yes	Yes	Yes				
		30		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
		60		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

6.11.3 Co-existence studies

Table 6.11.3-1 lists Band18+3.3-4.2GHz 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.11.3-1: Band 18 and Band n77 UL harmonics and IMD products

UE UL carriers	Fx_low	Fx_high	Fy_low	Fy_high
UL frequency (MHz)	815	830	3300	4200
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1630	1660	6600	8400
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2445	2490	9900	12600
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	3260	3320	13200	16800
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	4075	4150	16500	21000
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	2470	3385	4115	5030
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)	2570	1640	5770	7585
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)	4930	5860	7415	9230
Two-tone 3rd order IMD products (with maximum channel bandwidth)	|fx_low – fy_BWmax|	|fx_high + fy_BW max|	|fy_low – fx_BW max|	|fy_high + fx_BW max|
IMD frequency limits (MHz)	715	930	3280	4220
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)	1755	810	9070	11785
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	4940	6770		
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)	5745	6690	10715	13430
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	8230	10060		
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)	15985	12370	20	940
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)	10970	8240	4110	5955
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)	14015	17630	6560	7520
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)	11530	14260	9045	10890

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Based on the table, 4th, 5th order harmonic and 3rd, 4th, 5th order IMD may fall into own Rx of band 18, and 2nd, 3rd and 5th order IMD may fall into own Rx of NR band.

It should be noted that IMD will not be an issue for NR band (no self-interference) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.11.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.11.3-2: Band 18 and Band n77 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	YES		IMD4
Galileo	1559	-	1591	YES		IMD4
GLONASS	1591	-	1610	YES		IMD4
GPS	1563	-	1587	YES		IMD4
ISM band (2.4GHz)	2400	-	2483.5	YES	US/Europe	3rd harmonic, IMD2, IMD3
	2400	-	2494	YES	Asia	3rd harmonic, IMD2, IMD3
ISM band (5GHz)	5150	-	5925	YES	US	IMD3, IMD4, IMD5
	5150	-	5350	YES	Europe	IMD3, IMD4, IMD5
	5470	-	5725	YES		IMD3, IMD4, IMD5
	5150	-	5825	YES	Asia	IMD3, IMD4, IMD5

Table 6.11.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.11.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_18A-n77A	E-UTRA Band 1, 3, 11, 21, 28, 34, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	
	NR Band n257	26500	-	29500	[-5]	100	

6.11.4 ΔTIB and ΔRIB values

For DC_18A-n77A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.11.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_18A-n77A	18	0.3
	n77	0.8

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Table 6.11.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_19A-n77A	18	0
	n77	0.5

6.11.5 MSD

Although table 6.11.3-1 shows 3rd, 4th and 5th order IMD may fall into own Rx of band 18, only impacts from 5th IMD should be studied as approved in R4-1709965. In R4-1709964, it is approved that 5th IMD of DC_19A-n77A need not to be specified. Since band18 has similar frequency range as band 19 that results in the same IMD level, no IMD issue should be studied for own Rx range in this combination and MSD requirement due to IMD is shown in table 6.11.5-1.

Table 6.11.5-1: MSD due to IMD requirement for dual uplink DC_18A-n77A

E-UTRA+NR Band / Channel bandwidth / N_{RB} / Duplex mode							
EUTRA CA Configuration	**EUTRA+NR band**	**UL F_c (MHz)**	**UL/DL BW (MHz)**	**UL C_{LRB}**	**DL F_c (MHz)**	**MSD (dB)**	**Duplex mode**
DC_18A-n77A[1]	18	N/A	N/A	N/A	N/A	N/A	FDD
	n77	N/A	N/A	N/A	N/A	N/A	TDD
NOTE1: The reference sensitivity should only be verified when all configured RE's of n77 uplink are confined within frequencies 3600 – 4200 MHz. Requirement of other uplink frequency ranges is FFS.							

Table 6.11.5-2 lists the MSD due to 4th harmonic required for the dual connectivity configuration.

Table 6.11.5-2: MSD due to 5th harmonic for DC_18A-n77A

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)	100 MHz (dB)
18	n77[4,5]		[10.4]	[8.9]	[7.8]		[4.7]	[3.7]	[3]	[1.7]	[0.7]

Table 6.11.5-3 lists the UL configuration for the EN-DC configuration DC_18A-n77A.

Table 6.11.5-3: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for EN-DC in NR 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
18	n77	8	16	25	25[1], 25[2]						
NOTE 1: The configuration is used for measurement of MSD for NR channel bandwidth of 20MHz. NOTE 2: The configuration is used for measurement of MSD for NR channel bandwidth of 40MHz.											

6.11.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD) , or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.11.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.11.6-1.

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Table 6.11.6-1: Band 18 and Band n77 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_18A_n77A	18	a	-3	b	-1	4	18	IMD
	n77	c	1	d	0			
DC_18A_n77A	18	a	-4	b	-1	5	18	IMD
	n77	c	1	d	0			
DC_18A_n77A	18	a	4	b	0	4	n77	Harmonic
	n77	c	0	d	-1			
DC_18A_n77A	18	a	5	b	0	5	n77	Harmonic
	n77	c	0	d	-1			

Equations (6.11.6.1) and (6.11.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.11.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.11.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.11.6.2)$$

Formula (3-1) and (3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.11.6.3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.11.6.3\text{-}2)$$

6.12 DC_18A-n78A

6.12.1 Operating bands for DC

Table 6.12.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_18A-n78A	18	815 MHz – 830 MHz	860 MHz – 875 MHz	FDD
	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD

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6.12.2 Channel bandwidths per operating band for DC

Table 6.12.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	**E-UTRA and NR 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]**
DC_18A-n78A	18	15	Yes	Yes	Yes							115
	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	

6.12.3 Co-existence studies

Table 6.12.3-1 lists Band18+3.3-3.8GHz 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.12.3-1: Band 18 and Band n78 UL harmonics and IMD products

UE UL carriers	Fx_low	Fx_high	Fy_low	Fy_high
UL frequency (MHz)	815	830	3300	3800
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1630	1660	6600	7600
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2445	2490	9900	11400
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	3260	3320	13200	15200
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	4075	4150	16500	19000
IMD frequency limits (MHz)	2470	2985	4115	4630
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)	2170	1640	5770	6785
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)	4930	5460	7415	8430
Two-tone 3rd order IMD products (with maximum channel bandwidth)	|fx_low – fy_BWmax|	|fx_high + fy_BW max|	|fy_low – fx_BW max|	|fy_high + fx_BW max|
IMD frequency limits (MHz)	715	930	3280	3820
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)	1355	810	9070	10585
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	4940	5970		
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)	5745	6290	10715	12230
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	8230	9260		
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)	14385	12370	20	540
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)	9770	8240	4110	5155
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)	14015	16030	6560	7120
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)	11530	13060	9045	10090

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Based on the table, 4th harmonic and 3rd, 4th order IMD may fall into own Rx of band 18 and 3rd order IMD may fall into own Rx of NR band.

It should be noted that IMD will not be an issue for NR band (no self-interference) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.12.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.12.3-2: Band 18 and Band n78 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591			
Galileo	1559	-	1591			
GLONASS	1591	-	1610			
GPS	1563	-	1587			
ISM band (2.4GHz)	2400	-	2483.5	YES	US/Europe	3rd harmonic, IMD2
	2400	-	2494	YES	Asia	3rd harmonic, IMD2
ISM band (5GHz)	5150	-	5925	YES	US	IMD3, IMD4, IMD5
	5150	-	5350	YES	Europe	IMD3, IMD4, IMD5
	5470	-	5725	YES		IMD3, IMD4, IMD5
	5150	-	5825	YES	Asia	IMD3, IMD4, IMD5

Table 6.12.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.12.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_18A-n78A	E-UTRA Band 1, 3, 11, 21, 28, 34, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	
	NR Band n257	26500	-	29500	[-5]	100	

6.12.4 ΔTIB and ΔRIB values

For DC_18A-n78A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.12.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_18A-n78A	18	0.3
	n78	0.8

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Table 6.12.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_18A-n78A	18	0
	n78	0.5

6.12.5 MSD

Although table 6.12.3-1 shows 3rd and 4th order IMD may fall into own Rx of band 18, there is no IMD issue for own Rx range in this combination taking actual spectrum holding into account as approved in R4-1709965 and the MSD requirement due to IMD is shown in table 6.12.5-1.

Table 6.12.5-1: MSD due to IMD requirement for dual uplink DC_18A-n78A

E-UTRA+NR Band / Channel bandwidth / N_{RB} / Duplex mode							
EUTRA CA Configuration	EUTRA+NR band	UL F_c (MHz)	UL/DL BW (MHz)	UL C_{LRB}	DL F_c (MHz)	MSD (dB)	Duplex mode
DC_18A-n78A[1]	18	N/A	N/A	N/A	N/A	N/A	FDD
	n78	N/A	N/A	N/A	N/A	N/A	TDD
NOTE1: The reference sensitivity should only be verified when all configured RE's of n78 uplink are confined within frequencies 3600 – 3800 MHz. Requirement of other uplink frequency ranges is FFS.							

For 4th order harmonic, no MSD should be specified considering spectrum allocation.

6.12.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.12.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.12.6-1.

Table 6.12.6-1: Band 18 and Band n78 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_18A_n78A	18	a	-3	b	-1	4	18	IMD
	n78	c	1	d	0			
DC_18A_n78A	18	a	4	b	0	4	n78	Harmonic
	n78	c	0	d	-1			

Equations (6.12.6.1) and (6.12.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.12.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.12.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.12.6.2)$$

Formula (6.12.6.3-1) and (6.12.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.12.6.3\text{-}1)$$

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$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX\,2}}{2} \quad (6.12.6.3\text{-}2)$$

6.13 DC_18A-n79A

6.13.1 Operating bands for DC

Table 6.13.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_18A-n79A	18	815 MHz – 830 MHz	860 MHz – 875 MHz	FDD
	n79	4400 MHz – 5000 MHz	4400 MHz – 5000 MHz	TDD

6.13.2 Channel bandwidths per operating band for DC

Table 6.13.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_18A-n79A	18	15	Yes	Yes	Yes							115
	n79	15					Yes	Yes				
		30					Yes	Yes	Yes	Yes	Yes	
		60					Yes	Yes	Yes	Yes	Yes	

6.13.3 Co-existence studies

Table 6.13.3-1 lists Band18+4.4-5GHz 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.13.3-1: Band 18 and Band n79 UL harmonics and IMD products

UE UL carriers	Fx_low	Fx_high	Fy_low	Fy_high
UL frequency (MHz)	815	830	4400	5000
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1630	1660	8800	10000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2445	2490	13200	15000
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	3570	4185	5215	5830
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)	3370	2740	7970	9185
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)	6030	6660	9615	10830
Two-tone 3rd order IMD products (withmaximum channel bandwidth)	|f1_low – f2_BWmax|	|f1_high + f2_BW max|	|f2_low – f1_BW max|	|f2_high + f1_BW max|
IMD frequency limits (MHz)	715	930	4380	5020
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)	2555	1910	12370	14185
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	7140	8370		
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)	6845	7490	14015	15830
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	10430	11660		
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)	19185	16770	1080	1740
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)	13370	11540	6310	7555
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)	18415	20830	7660	8320
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)	14830	16660	11245	12490

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Based on the table, 3rd order IMD may fall into own Rx of band 18, and 3rd order IMD may fall into own Rx of NR band.

It should be noted that IMD will not be an issue for NR band (no self-interference) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.13.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.13.3-2: Band 18 and Band n79 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	YES		IMD5
Galileo	1559	-	1591	YES		IMD5
GLONASS	1591	-	1610	YES		IMD5
GPS	1563	-	1587	YES		IMD5
ISM band (2.4GHz)	2400	-	2483.5	YES	US/Europe	3rd harmonic
	2400	-	2494	YES	Asia	3rd harmonic
ISM band (5GHz)	5150	-	5925	YES	US	IMD2
	5150	-	5350	YES	Europe	IMD2
	5470	-	5725	YES		IMD2
	5150	-	5825	YES	Asia	IMD2

Table 6.13.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.13.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_18A-n79A	E-UTRA Band 1, 3, 11, 21, 28, 34, 42, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	
	NR Band n257	26500	-	29500	[-5]	100	

6.13.4 ΔTIB and ΔRIB values

For DC_18A-n79A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.13.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_18A-n79A	18	0
	n79	0

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Table 6.13.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_18A-n79A	18	0
	n79	0

6.13.5 MSD

There is no MSD issue for this DC configuration

6.13.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.13.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.13.6-1.

Table 6.13.6-1: Band 18 and Band n79 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_18A_n79A	18	a	6	b	0	6	n79	Harmonic
	n79	c	0	d	-1			

Equations (6.13.6.1) and (6.13.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.13.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.13.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.13.6.2)$$

Formula (6.13.6.3-1) and (6.13.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.13.6.3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.13.6.3\text{-}2)$$

6.14 DC_18A-n257A

6.14.1 Operating bands for DC

Table 6.14.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_18A_n257	18	815 MHz – 830 MHz	860 MHz – 875 MHz	FDD
	n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD

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6.14.2 Channel bandwidths per operating band for DC

Table 6.14.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	[50 MHz]	100 MHz	200 MHz	400 MHz	Maximum aggregated bandwidth [MHz]
DC_18A_n257	18	15	Yes	Yes	Yes						415
	n257	60					Yes	Yes	Yes		
		120					Yes	Yes	Yes	Yes	

6.14.3 Co-existence studies

Table 6.14.3-1 lists Band18+26.5-29.5GHz 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.14.3-1: Band 18 and Band n257 UL harmonics and IMD products

UE UL carriers	Fx_low	Fx_high	Fy_low	Fy_high
UL frequency (MHz)	815	830	26500	29500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1630	1660	53000	59000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2445	2490	79500	88500
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	25670	28685	27315	30330
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)	27870	24840	52170	58185
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)	28130	31160	53815	59830
Two-tone 3rd order IMD products (with maximum channel bandwidth)	|fx_low – fy_BWmax|	|fx_high + fy_BW max|	|fy_low – fx_BW max|	|fy_high + fx_BW max|
IMD frequency limits (MHz)	415	1230	26480	29520
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)	27055	24010	78670	87685
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	51340	57370		
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)	28945	31990	80315	89330
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	54630	60660		
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)	117185	105170	23180	26240
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)	86870	77840	50510	56555
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)	106815	118830	29760	32820
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)	81130	90160	55445	61490

Based on the table, 3rd order IMD may fall into own Rx of band 18, and 2nd, 3rd and 4th order IMD may fall into own Rx of NR band.

It should be noted that IMD will not be an issue for NR band (no self-interference) even through the IMD products may fall into the concerning band.

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When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.14.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.14.3-2: Band 18 and Band n257 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591			
Galileo	1559	-	1591			
GLONASS	1591	-	1610			
GPS	1563	-	1587			
ISM band (2.4GHz)	2400	-	2483.5	YES	US/Europe	3rd harmonic
	2400	-	2494	YES	Asia	3rd harmonic
ISM band (5GHz)	5150	-	5925		US	
	5150	-	5350		Europe	
	5470	-	5725			
	5150	-	5825		Asia	

Table 6.14.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.14.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_18A-n257A	E-UTRA Band 1, 3, 11, 21, 28, 34, 42, 65, n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	

6.14.4 ΔTIB and ΔRIB values

For DC_18A_n257, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.14.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_18A_n257	18	0
	n257	0

Table 6.14.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_18A_n257	18	0
	n257	0

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6.14.5 MSD

There is no MSD issue for this DC configuration.

6.15 DC_19A-n77

6.15.1 Operating bands for DC

Table 6.15.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_19A-n77	19	830 MHz – 845 MHz	875 MHz – 890 MHz	FDD
	n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	TDD

6.15.2 Channel bandwidths per operating band for DC

Table 6.15.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_19A-n77A	19	15	Yes	Yes	Yes							115
	n77	15		Yes	Yes	Yes	Yes	Yes				
		30		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
		60		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
DC_19A-n77C	3	15	Yes	Yes	Yes							215
	n77	See CA_n77C in Table 5.5A.1-1 in TS 38.101-1 [3]										

6.15.3 Co-existence studies

Table 6.15.3-1 lists Band 19 +Band n77 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.15.3-1: Band 19 and Band n77 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	830	845	3300	4200
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1660	1690	6600	8400
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2490	2535	9900	12600
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	2455	3370	4130	5045
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)	1610	2540	5755	7570
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)	4960	5890	7430	9245
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)	730	945	3280	4220
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)	765	1710	9055	11770
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	4910	6740		
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)	5790	6735	10730	13445
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	8260	10090		
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)	12355	15970	80	880
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)	8210	10940	4065	5910
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)	14030	17645	6620	7580
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)	11560	14290	9090	10935

Based on Table 6.15.3-1;

3rd order harmonic may fall into Rx frequencies of bands 41

2nd order IMD may also fall into Rx frequencies of band 7, 38, 41, 69 and n78

3rd order IMD may also fall into own Rx of band 19 and Rx frequencies of bands 1, 2, 3, 4, 5, 6, 8, 9, 10, 12, 13, 14, 17, 18, 20, 22, 23, 25, 26, 27, 28, 30, 33, 34, 35, 36, 37, 39, 40, 41, 42, 43, 44, 46, 47, 48, 65, 66, 67, 68, 70, n78 and n79

4th order IMD may also fall into own Rx of band 19 and Rx frequencies of bands 5, 6, 8, 11, 14, 18, 20, 21, 24, 26, 27, 28, 44, 45, 46, 47, 68 and n79

5th order IMD may also fall into own Rx of band 19 and Rx frequencies of bands 5, 6, 12, 13, 14, 17, 18, 20, 26, 27, 28, 29, 31, 44, 46, 47, 67, 68 and n79

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.15.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.15.3-2: 2UL Band 19 +Band n77 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD4
Galileo	1559	-	1591	Yes		IMD4
GLONASS	1591	-	1610	Yes		IMD4
GPS	1563	-	1587	Yes		IMD4
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD2, 3
	2400	-	2494	Yes	Asia	Harmonic3, IMD2, 3
ISM band (5GHz)	5150	-	5925	Yes	US	IMD3, 4, 5
	5150	-	5350	Yes	Europe	IMD3, 4, 5
	5470	-	5725	Yes		IMD3, 4, 5
	5150	-	5825	Yes	Asia	IMD3, 4, 5

Table 6.15.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.15.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_19A-n77A	E-UTRA Band 1, 3, 11, 21, 28, 34, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	
	NR Band n257	26500	-	29500	[-5]	100	

6.15.4 ΔT_{IB} and ΔR_{IB} values

For DC_19A-n77, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.15.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_19A-n77	19	0.3
	n77	0.8

Table 6.15.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_19A-n77	19	0
	n77	0.5

6.15.5 MSD

Table 6.15.5-1 lists the MSD due to 5th harmonic required for the dual connectivity configuration.

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Table 6.15.5-1: Reference sensitivity for the DC configuration for 5th harmonic

Channel bandwidth											
EUTRA/NR DC Configuration	EUTRA/NR band	5 MHz	10 MHz	15 MHz	20 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Duplex mode
CA_19A-n77A	19	-99.8	-96.8	-95	-93.8						FDD
	n77		[-85.4]	[-85.1]	[-84.9]	[-84.9]	[-84.9]	[-84.9]	[-84.9]	[-84.9]	TDD

For IMD5, the worst case is that there is 17.5 MHz frequency offset between the IM center of 865 MHz and the victim center frequency of 877.5 MHz. Considering the correction factor, no MSD should be specified for this case.

6.15.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics or inter-modulation products (IMD) based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.15.3 co-existence studies which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.15.6-1.

Table 6.15.6-1: Band 19 and Band n77 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_19A_n77	19	a	-3	b	-1	4	19	IMD
	n77	c	1	d	0			
DC_19A_n77	19	a	-4	b	-1	5	19	IMD
	n77	c	-1	d	0			
DC_19A_n77	19	a	4	b	0	4	n77	Harmonic
	n77	c	0	d	-1			
DC_19A_n77	19	a	5	b	0	5	n77	Harmonic
	n77	c	0	d	-1			

Equations (6.15.6.1) and (6.15.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.15.6-1 and CBW stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.15.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.15.6.2)$$

Formula (3-1) and (3-2) below are then used to indicate when the interference is overlapping with RX1 and RX2, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.15.6.3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.15.6.3\text{-}2)$$

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6.16 DC_19A-n78

6.16.1 Operating bands for DC

Table 6.16.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_19A-n78	19	830 MHz – 845 MHz	875 MHz – 890 MHz	FDD
	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD

6.16.2 Channel bandwidths per operating band for DC

Table 6.16.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_19A-n78A	19	15	Yes	Yes	Yes							115
	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	
DC_19A-n78C	19	15	Yes	Yes	Yes							215
	n78	See CA_n78C in Table 5.5A.1-1 in TS 38.101-1 [3]										

6.16.3 Co-existence studies

Table 6.16.3-1 lists Band 19 +Band n78 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.16.3-1: Band 19 and Band n78 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	830	845	3300	3800
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1660	1690	6600	7600
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2490	2535	9900	11400
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	2455	2970	4130	4645
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)	1610	2140	5755	6770
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)	4960	5490	7430	8445
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)	730	945	3280	3820
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)	765	1310	9055	10570
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	4910	5940		
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)	5790	6335	10730	12245
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	8260	9290		
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)	12355	14370	80	480
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)	8210	9740	4065	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)	14030	16045	6620	7180
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)	11560	13090	9090	10135

Based on Table 6.16.3-1;

3rd order harmonic may fall into Rx frequencies of band 41

2nd order IMD may also fall into Rx frequencies of band 7, 38, 41, 69, n77, n79

3rd order IMD may also fall into own Rx of band 19 and Rx frequencies of bands 1, 2, 3, 4, 5, 6, 8, 9, 10, 12, 13, 14, 17, 18, 20, 22, 25, 26, 27, 28, 33, 34, 35, 36, 37, 39, 42, 43, 44, 46, 47, 48, 65, 66, 67, 68, 70, n77 and n79

4th order IMD may also fall into own Rx of band 19 and Rx frequencies of bands 5, 6, 8, 14, 18, 20, 26, 27, 28, 44, 46, 47, 68 and n79

5th order IMD may also fall into Rx frequencies of bands 31, n77 and n79

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.16.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.16.3-2: 2UL Band 19 +Band n78 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591			
Galileo	1559	-	1591			
GLONASS	1591	-	1610			
GPS	1563	-	1587			
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD2
	2400	-	2494	Yes	Asia	Harmonic3, IMD2
ISM band (5GHz)	5150	-	5925	Yes	US	IMD3, 4
	5150	-	5350	Yes	Europe	IMD3, 4
	5470	-	5725	Yes		IMD3, 4
	5150	-	5825	Yes	Asia	IMD3, 4

Table 6.16.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.16.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_19A-n78A	E-UTRA Band 1, 3, 11, 21, 28, 34, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	
	NR Band n257	26500	-	29500	[-5]	100	

6.16.4 ΔT_{IB} and ΔR_{IB} values

For DC_19A-n78, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.16.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_19A-n78	19	0.3
	n78	0.8

Table 6.16.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_19A-n78	19	0
	n78	0.5

6.16.5 MSD

There is no MSD issue for this DC configuration.

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6.16.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.16.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.16.6-1.

Table 6.16.6-1: Band 19 and Band n78 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_19A_n78A	19	a	-3	b	-1	4	19	IMD
	n78	c	1	d	0			
DC_19A_n78A	19	a	4	b	0	4	n78	Harmonic
	n78	c	0	d	-1			

Equations (6.16.6.1) and (6.16.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.16.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.16.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.16.6.2)$$

Formula (6.16.6.3-1) and (6.16.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.16.6.3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.16.6.3\text{-}2)$$

6.17 DC_19A-n79

6.17.1 Operating bands for DC

Table 6.17.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band BS receive / UE transmit F_{UL_low} – F_{UL_high}	Downlink (DL) band BS transmit / UE receive F_{DL_low} – F_{DL_high}	Duplex mode
DC_19A-n79	19	830 MHz – 845 MHz	875 MHz – 890 MHz	FDD
	n79	4400 MHz – 5000 MHz	4400 MHz – 5000 MHz	TDD

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6.17.2 Channel bandwidths per operating band for DC

Table 6.17.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	**E-UTRA and NR 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]**
DC_19A-n79A	19	15	Yes	Yes	Yes							115
	n79	15					Yes	Yes				
		30					Yes	Yes	Yes	Yes	Yes	
		60					Yes	Yes	Yes	Yes	Yes	
DC_19A-n79C	19	15	Yes	Yes	Yes							215
	n79	See CA_n79C in Table 5.5A.1-1 in TS 38.101-1 [3]										

6.17.3 Co-existence studies

Table 6.17.3-1 lists Band 19 +Band n79 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.17.3-1: Band 19 and Band n79 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	830	845	4400	5000
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1660	1690	8800	10000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2490	2535	13200	15000
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	3555	4170	5230	5845
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)	2710	3340	7955	9170
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)	6060	6690	9630	10845
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)	730	945	4385	5015
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)	1865	2510	12355	14170
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	7110	8340		
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)	6890	7535	14030	15845
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	10460	11690		
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)	16755	19170	1020	1680
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)	11510	11340	6265	7510
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)	18430	20845	7720	8380
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)	14860	16690	11290	12535

Based on Table 6.17.3-1;

3rd order harmonic may fall into Rx frequencies of bands 41

2nd order IMD may also fall into Rx frequencies of bands 22, 42, 43, 46, 48, n77 (3.3 – 4.2 GHz) and n78 (3.3 – 3.8 GHz)

3rd order IMD may also fall into own Rx of band 19 and Rx frequencies of bands5, 6, 8, 12, 13, 14, 17, 18, 20, 26, 27, 28, 44, 67, 68, n77 (3.3 – 4.2 GHz) and n78 (3.3 – 3.8 GHz)

4th order IMD may also fall into Rx frequencies of bands 1, 2, 3, 4, 9, 10, 23, 25, 30, 33, 34, 35, 36, 37, 39, 40, 41, 65, 66, 70

5th order IMD may also fall into Rx frequencies of bands 11, 21, 24, 45

When 2UL inter-band DC UE is operating with other systems such as Wi-Fi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.17.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.17.3-2: 2UL Band 19 +Band n79 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD5
Galileo	1559	-	1591	Yes		IMD5
GLONASS	1591	-	1610	Yes		IMD5
GPS	1563	-	1587	Yes		IMD5
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD4
	2400	-	2494	Yes	Asia	Harmonic3, IMD4
ISM band (5GHz)	5150	-	5925	Yes	US	IMD2
	5150	-	5350	Yes	Europe	IMD2
	5470	-	5725	Yes		IMD2
	5150	-	5825	Yes	Asia	IMD2

Table 6.17.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.17.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_19A-n79A	E-UTRA Band 1, 3, 11, 21, 28, 34, 42, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	
	NR Band n257	26500	-	29500	[-5]	100	

6.17.4 ΔT_{IB} and ΔR_{IB} values

For DC_19A-n79, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.17.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_19A-n79	19	0
	n79	0

Table 6.17.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_19A-n79	19	0
	n79	0

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6.17.5 MSD

For 6th harmonic, Even if HTF is implemented, little IL impact is expected considering that reported MSD in LTE Band 46 discussion is up to 8.8 dB. Therefore it is agreed to specify no MSD requirement for the 6th harmonic cases and not to assume additional IL i.e. ΔTib and ΔRib due to HTF. For 5th harmonic mixing, the MSD values are given in Table 6.17.5-1.

Table 6.17.5-1 MSD due to harmonic mixing for DC_19-n79

MSD due to harmonic mixing 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
n79	19	29.5	26.5	24.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NOTE 1: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (higher) band for which the mixing product due to harmonic of victim (lower) band LO with leakage of aggressor (higher) band is within the downlink transmission bandwidth of a victim (lower) band.											
NOTE 2: The requirements should be verified for DL EARFCN of the victim (lower) band (superscript LB) such that $f_{DL}^{LB} = \lfloor f_{UL}^{HB} / 0.5 \rfloor 0.1$ in MHz and $F_{DL\_low}^{LB} + BW_{Channel}^{LB}/2 \le f_{DL}^{LB} \le F_{DL\_high}^{LB} - BW_{Channel}^{LB}/2$ with f_{DL}^{LB} carrier frequency in the victim (lower) band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the lower band.											

Uplink configuration in Table shall be considered for the harmonic mixing test for DC_19-n79. The purpose is to verify the REFSENS degradation of the low band, therefore, there is no need to configure all the CBWs for the NR band. For larger SCS for the NR band, the RB allocation should be as close as the bandwidth for15kHz SCS.

Table 6.17.5-2 Uplink configuration for the high band (exceptions) for NR

NR Band / Channel bandwidth of the high band / N_{RB}												
LTE-NR DC band combination	UL band	SCS	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz
DC_19-n79	n79	15	25	50	75							
NOTE 1: RB allocations in this table are corresponding to channel bandwidth of Band 19.												

6.17.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.17.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.17.6-1.

Table 6.17.6-1: Band 19 and Band n79 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_19A_n79A	19	a	0	b	-5	5	19	Harmonic mixing
	n79	c	1	d	0			
DC_19A_n79A	19	a	6	b	0	6	n79	Harmonic
	n79	c	0	d	-1			

Equations (6.17.6.1) and (6.17.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.17.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.17.6.1)$$

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$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.17.6.2)$$

Formula (6.17.6.3-1) and (6.17.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.17.6.3.1)$$

$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.17.6.3.2)$$

6.18 DC_21A-n77

6.18.1 Operating bands for DC

Table 6.18.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band BS receive / UE transmit $F_{UL\_low} – F_{UL\_high}$	Downlink (DL) band BS transmit / UE receive $F_{DL\_low} – F_{DL\_high}$	Duplex mode
DC_21A-n77	21	1447.9 MHz – 1462.9 MHz	1495.9 MHz – 1510.9 MHz	FDD
	n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	TDD

6.18.2 Channel bandwidths per operating band for DC

Table 6.18.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_21A-n77A	21	15	Yes	Yes	Yes							115
	n77	15		Yes	Yes	Yes	Yes	Yes				
		30		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
		60		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
DC_21A-n77C	21	15	Yes	Yes	Yes							215
	n77	See CA_n77C in Table 5.5A.1-1 in TS 38.101-1 [3]										

6.18.3 Co-existence studies

Table 6.18.3-1 lists Band 21 +Band n77 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.18.3-1: Band 21 and Band n77 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1447.9	1462.9	3300	4200
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	2895.8	2925.8	6600	8400
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	4343.7	4388.7	9900	12600
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	1837.1	2752.1	4747.9	5662.9
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)	374.2	1304.2	5137.1	6952.1
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)	6195.8	7125.8	8047.9	9862.9
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)	1347.9	1562.9	3285	4215
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)	143.7	1088.7	8437.1	11152.1
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	3674.2	5504.2		
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)	7643.7	8588.7	11347.9	14062.9
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	9495.8	11325.8		
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)	11737.1	15352.1	1591.6	2551.6
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)	6974.2	9704.2	2211.3	4056.3
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)	14647.9	18262.9	9091.6	10051.6
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)	12795.8	15525.8	10943.7	12788.7

Based on Table 6.18.3-1;

2nd order IMD may also fall into Rx frequencies of bands 1, 2, 3, 4, 7, 9, 10, 23, 25, 30, 33, 34, 35, 36, 37, 38, 39, 40, 41, 46, 65, 66, 69, 70 and n79

3rd order IMD may also fall into own Rx of band 21 and Rx frequencies of bands 5, 6, 8, 11, 12, 13, 14, 17, 18, 19, 20, 22, 24, 26, 27, 28, 29, 31, 42, 43, 44, 45, 46, 47, 48, 67, 68, 70 and n78

4th order IMD may also fall into Rx frequencies of bands 5, 6, 8, 12, 13, 14, 17, 18, 19, 20, 26, 27, 28, 29, 31, 43, 44, 46, 48, 67, 68, n78 and n79

5th order IMD may also fall into Rx frequencies of bands 1, 2, 3, 4, 7, 9, 10, 22, 23, 25, 30, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 48, 65, 66, 69, 70 and n78

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.18.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.18.3-2: 2UL Band 21 +Band n77 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD3
Galileo	1559	-	1591	Yes		IMD3
GLONASS	1591	-	1610	Yes		IMD5
GPS	1563	-	1587			
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD2, 5
	2400	-	2494	Yes	Asia	IMD2, 5
ISM band (5GHz)	5150	-	5925	Yes	US	IMD2, 3, 4
	5150	-	5350	Yes	Europe	IMD2, 3, 4
	5470	-	5725	Yes		IMD2, 3, 4
	5150	-	5825	Yes	Asia	IMD2, 3, 4

Table 6.18.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.18.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_21A-n77A	E-UTRA Band 1, 3, 18, 19, 21, 28, 34, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	
	NR Band n257	26500	-	29500	[-5]	100	

6.18.4 ΔT_{IB} and ΔR_{IB} values

For DC_21A-n77, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.18.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_21A-n77	21	0.4
	n77	0.8

Table 6.18.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_21A-n77	21	0
	n77	0.5

6.18.5 MSD

There is no MSD issue for this DC configuration.

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6.19 DC_21A-n78

6.19.1 Operating bands for DC

Table 6.19.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band	Downlink (DL) band	Duplex mode
		BS receive / UE transmit	BS transmit / UE receive	
		$F_{UL\_low} – F_{UL\_high}$	$F_{DL\_low} – F_{DL\_high}$	
DC_21A-n78	21	1447.9 MHz – 1462.9 MHz	1495.9 MHz – 1510.9 MHz	FDD
	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD

6.19.2 Channel bandwidths per operating band for DC

Table 6.19.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_21A-n78A	21	15	Yes	Yes	Yes							115
	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	
DC_21A-n78C	21	15	Yes	Yes	Yes							215
	n78	See CA_n78C in Table 5.5A.1-1 in TS 38.101-1 [3]										

6.19.3 Co-existence studies

Table 6.19.3-1 lists Band 21 +Band n78 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.19.3-1: Band 21 and Band n78 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1447.9	1462.9	3300	3800
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	2895.8	2925.8	6600	7600
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	4343.7	4388.7	9900	11400
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	1837.1	2352.1	4747.9	5262.9
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)	374.2	904.2	5137.1	6152.1
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)	6195.8	6725.8	8047.9	9062.9
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)	1347.9	1562.9	3285	3815
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)	543.7	1088.7	8437.1	9952.1
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	3674.2	4704.2		
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)	7643.7	8188.7	11347.9	12862.9
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	9495.8	10525.8		
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)	11737.1	13752.1	1991.6	2551.6
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)	6974.2	8504.2	2211.3	3256.3
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)	14647.9	16662.9	9091.6	9651.6
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)	12795.8	14325.8	10943.7	11988.7

Based on Table 6.19.3-1;

2nd order IMD may also fall into Rx frequencies of bands 1, 2, 3, 4, 9, 10, 23, 25, 30, 33, 34, 35, 36, 37, 39, 40, 46, 65, 66, 70 and n79

3rd order IMD may also fall into own Rx of band 21 and Rx frequencies of bands 5, 6, 11, 12, 13, 14, 17, 18, 19, 20, 26, 27, 28, 29, 43, 44, 48, 67, 68 and n77

4th order IMD may also fall into Rx frequencies of bands 5, 6, 8, 12, 13, 14, 17, 18, 19, 20, 26, 27, 28, 29, 43, 44, 48, 67, 68 n77 and n79

5th order IMD may also fall into Rx frequencies of bands 1, 4, 7, 10, 23, 25, 30, 34, 38, 40, 41, 65, 66, 69 and 70

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.19.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.19.3-2: 2UL Band 21 +Band n78 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD3
Galileo	1559	-	1591	Yes		IMD3
GLONASS	1591	-	1610			
GPS	1563	-	1587			
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD5
	2400	-	2494	Yes	Asia	IMD5
ISM band (5GHz)	5150	-	5925	Yes	US	IMD2, 3
	5150	-	5350	Yes	Europe	IMD2, 3
	5470	-	5725	Yes		IMD3
	5150	-	5825	Yes	Asia	IMD2, 3

Table 6.19.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.19.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_21A-n78A	E-UTRA Band 1, 3, 18, 19, 21, 28, 34, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	
	NR Band n257	26500	-	29500	[-5]	100	

6.19.4 ΔT_{IB} and ΔR_{IB} values

For DC_21A-n78, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.19.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_21A-n78	21	0.4
	n78	0.8

Table 6.19.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_21A-n78	21	0
	n78	0.5

6.19.5 MSD

There is no MSD issue for this DC configuration.

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6.20 DC_21A-n79

6.20.1 Operating bands for DC

Table 6.20.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_21A-n79	21	1447.9 MHz – 1462.9 MHz	1495.9 MHz – 1510.9 MHz	FDD
	n79	4400 MHz – 5000 MHz	4400 MHz – 5000 MHz	TDD

6.20.2 Channel bandwidths per operating band for DC

Table 6.20.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_21A-n79A	21	15	Yes	Yes	Yes							115
	n79	15					Yes	Yes				
		30					Yes	Yes	Yes	Yes	Yes	
		60					Yes	Yes	Yes	Yes	Yes	
DC_21A-n79C	21	15	Yes	Yes	Yes							215
	n79	See CA_n79C in Table 5.5A.1-1 in TS 38.101-1 [3]										

6.20.3 Co-existence studies

Table 6.20.3-1 lists Band 21 +Band n79 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.20.3-1: Band 21 and Band n79 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1447.9	1462.9	4400	5000
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	2895.8	2925.8	8800	10000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	4343.7	4388.7	13200	15000
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	2937.1	3552.1	5847.9	6462.9
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)	1474.2	2104.2	7337.1	8552.1
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)	7295.8	7925.8	10247.9	14462.9
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)	1347.9	1562.9	4385	5015
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)	11.3	656.3	11737.1	13552.1
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	5874.2	7104.2		
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)	8743.7	9388.7	14647.9	16462.9
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	11695.8	12925.8		
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)	16137.1	18552.1	791.6	1451.6
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)	10274.2	12104.2	4411.3	5656.3
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)	19047.9	21462.9	10191.6	10851.6
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)	16095.8	17925.8	13143.7	14388.7

Based on Table 6.20.3-1;

2nd order IMD may also fall into Rx frequencies of bands 22, 42, 46, 47, 48, n77 (3.3 – 4.2 GHz) and n78 (3.3 – 3.8 GHz)

3rd order IMD may also fall into own Rx of band 21 and Rx frequencies of bands2, 3, ,9, 11, 24, 25, 33, 34, 35, 36, 37, 39, 45, 70

4th order IMD may also fall into Rx frequencies of bands 31, 46, 47

5th order IMD may also fall into Rx frequencies of bands 5, 6, 8, 18, 19, 20, 26, 27, 28, 44, 45, 46

When 2UL inter-band DC UE is operating with other systems such as Wi-Fi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.20.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.20.3-2: 2UL Band 21 +Band n79 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD3
Galileo	1559	-	1591	Yes		IMD3
GLONASS	1591	-	1610	Yes		IMD3
GPS	1563	-	1587	Yes		IMD3
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	Yes	US	IMD2, IMD4, IMD5
	5150	-	5350	Yes	Europe	IMD5
	5470	-	5725	Yes		IMD5
	5150	-	5825	Yes	Asia	IMD5

Table 6.20.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.20.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_21A-n79A	E-UTRA Band 1, 3, 18, 19, 21, 28, 34, 42, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	
	NR Band n257	26500	-	29500	[-5]	100	

6.20.4 ΔT_{IB} and ΔR_{IB} values

For DC_21A-n79, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.20.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_21A-n79	21	0
	n79	0

Table 6.20.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_21A-n79	21	0
	n79	0

6.20.5 MSD

Table 6.20.5-1 lists the MSD required for the dual connectivity configuration.

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Table 6.20.5-1: MSD for the DC configuration for IMD3

DC bands	UL DC	IMD		UL F_c (MHz)	UL BW (MHz)	UL RB #	DL F_c (MHz)	DL BW (MHz)	CF (dB)	MSD (dB)
DC_21A-n79A	21	IMD3	$\lvert f_{B79} - 2*f_{B21} \rvert$	1457.5	5	25	1505.5	5	1.8	**[18.4]**
	n79			4420.5	40	216	4420.5	40		N/A

Table 6.20.5-2: Reference sensitivity for the DC configuration for 3rd harmonic mixing

Channel bandwidth											
EUTRA/NR DC Configuration	EUTRA/NR band	5 MHz	10 MHz	15 MHz	20 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Duplex mode
CA_21A-n79A	21	-60.7	-60.7	-60.7							FDD
	n79					TBD	TBD	TBD	TBD	TBD	TDD

6.20.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.20.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.20.6-1.

Table 6.20.6-1: Band 21 and Band n79 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_21A_n79A	21	a	-2	b	-1	3	21	IMD
	n79	c	1	d	0			
DC_21A_n79A	21	a	0	b	3	3	21	Harmonic mixing
	n79	c	-1	d	0			

Equations (6.20.6.1) and (6.20.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.20.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.20.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.20.6.2)$$

Formula (6.20.6.3-1) and (6.20.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.20.6.3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.20.6.3\text{-}2)$$

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6.21 DC_26A-n77A

6.21.1 Operating bands for DC

Table 6.21.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_26A-n77A	26	814 MHz – 849 MHz	859 MHz – 894 MHz	FDD
	n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	TDD

6.21.2 Channel bandwidths per operating band for DC

Table 6.21.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_26A-n77A	26	15	Yes	Yes	Yes							115
	n77	15		Yes	Yes	Yes	Yes	Yes				
		30		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
		60		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

6.21.3 Co-existence studies

Table 6.21.3-1 lists Band26+3.3-4.2GHz 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.21.3-1: Band 26 and Band n77 UL harmonics and IMD products

UE UL carriers	Fx_low	Fx_high	Fy_low	Fy_high
UL frequency (MHz)	814	849	3300	4200
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1628	1698	6600	8400
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2442	2547	9900	12600
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	3256	3396	13200	16800
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	4070	4245	16500	21000
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	2451	3386	4114	5049
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)	2572	1602	5751	7586
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)	4928	5898	7414	9249
Two-tone 3rd order IMD products (with maximum channel bandwidth)	|fx_low – fy_BWmax|	|fx_high + fy_BW max|	|fy_low – fx_BW max|	|fy_high + fx_BW max|
IMD frequency limits (MHz)	714	949	3280	4220
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)	1758	753	9051	11786
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	4902	6772		
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)	5742	6747	10714	13449
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	8228	10098		
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)	15986	12351	96	944
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)	10972	8202	4053	5958
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)	14014	17649	6556	7596
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)	11528	14298	9042	10947

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Based on the table, 3rd, 4th, 5th order IMD may fall into own Rx of band 26, 4th , 5th order harmonic and 2nd, 3rd, 5th order IMD may fall into own Rx of NR band.

It should be noted that IMD will not be an issue for NR band (no self-interference) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.21.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.21.3-2: Band 26 and Band n77 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	YES		IMD4
Galileo	1559	-	1591	YES		IMD4
GLONASS	1591	-	1610	YES		IMD4
GPS	1563	-	1587	YES		IMD4
ISM band (2.4GHz)	2400	-	2483.5	YES	US/Europe	3rd harmonic, IMD2, IMD3
	2400	-	2494	YES	Asia	3rd harmonic, IMD2, IMD3
ISM band (5GHz)	5150	-	5925	YES	US	IMD3, IMD4, IMD5
	5150	-	5350	YES	Europe	IMD3, IMD4, IMD5
	5470	-	5725	YES		IMD3, IMD4, IMD5
	5150	-	5825	YES	Asia	IMD3, IMD4, IMD5

Table 6.21.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.21.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_26A-n77A	E-UTRA Band 1, 3, 11, 21, 28, 34, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	
	NR Band n257	26500	-	29500	[-5]	100	

6.21.4 ΔTIB and ΔRIB values

For DC_26A-n77A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.21.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_26A-n77A	26	0.3
	n77	0.8

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Table 6.21.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_26A-n77A	26	0
	n77	0.5

6.21.5 MSD

Table 6.21.5-1 lists the MSD due to 4th harmonic required for EN-DC configuration DC_26A-n77A.

Table 6.21.5-1: MSD due to 4th harmonic for DC_26A-n77A

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**
26	n77[1,2]		10.8	9.1	8		6				

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 4th 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 $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.4 \rfloor 0.1$ in MHz and $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$ 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 6.21.5-2 lists the UL configuration for the EN-DC configuration DC_26A-n77A.

Table 6.21.5-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for EN-DC in NR 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
26	n77	8	16	25	25[1], 25[2]						

NOTE 1: The configuration is used for measurement of MSD for NR channel bandwidth of 20MHz.
NOTE 2: The configuration is used for measurement of MSD for NR channel bandwidth of 40MHz.

Table 6.21.5-3 lists the MSD due to 5th harmonic required for EN-DC configuration DC_26A-n77A.

Table 6.21.5-3: MSD due to 5th harmonic for DC_26A-n77A

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)	100 MHz (dB)
26	n77[4,5]		[10.4]	[8.9]	[7.8]		[4.7]	[3.7]	[3]	[1.7]	[0.7]

Table 6.21.5-4 lists the UL configuration for the EN-DC configuration DC_26A-n77A.

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Table 6.21.5-4: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for EN-DC in NR 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
26	n77	8	16	25	25[1], 25[2]						
NOTE 1: The configuration is used for measurement of MSD for NR channel bandwidth of 20MHz. NOTE 2: The configuration is used for measurement of MSD for NR channel bandwidth of equal of larger than 40MHz.											

Table 6.21.5-5 lists the MSD required for the dual connectivity configuration.

Table 6.21.5-5: MSD due to IMD issue for DC_26A-n77A

E-UTRA Band / Channel bandwidth / N_{RB} / Duplex mode								Source of IMD
EUTRA/NR DC Configuration	EUTRA/NR band	UL F_c (MHz)	UL/DL BW (MHz)	UL C_{LRB}	DL F_c (MHz)	MSD (dB)	Duplex mode	
DC_26A-n77A	26	836.5	5	25	881.5	11.1	FDD	IMD4[1]
	n77	3390	10	50	3390	N/A	TDD	N/A
NOTE 1: This band is subject to IMD5 also which MSD is not specified.								

6.21.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics or inter-modulation products (IMD) based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.21.3 co-existence studies which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.21.6-1.

Table 6.21.6-1: Band 26 and Band n77 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_26A_n77	26	a	-3	b	-1	4	26	IMD
	n77	c	1	d	0			
DC_26A_n77	26	a	-4	b	-1	5	26	IMD
	n77	c	-1	d	0			
DC_26A_n77	26	a	4	b	0	4	n77	Harmonic
	n77	c	0	d	-1			
DC_26A_n77	26	a	5	b	0	5	n77	Harmonic
	n77	c	0	d	-1			

Equations (6.21.6.1) and (6.21.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.21.6-1 and CBW stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.21.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.21.6.2)$$

Formula (6.21.6.3-1) and (6.21.6.3-2) below are then used to indicate when the interference is overlapping with RX1 and RX2, respectively.

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$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.21.6.3\text{-}1)$$

$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.21.6.3\text{-}2)$$

6.22 DC_26A-n78A

6.22.1 Operating bands for DC

Table 6.22.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band BS receive / UE transmit F_{UL_low} – F_{UL_high}	Downlink (DL) band BS transmit / UE receive F_{DL_low} – F_{DL_high}	Duplex mode
DC_26A-n78A	26	814 MHz – 849 MHz	859 MHz – 894 MHz	FDD
	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD

6.22.2 Channel bandwidths per operating band for DC

Table 6.22.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_26A-n78A	26	15	Yes	Yes	Yes							115
	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	

6.22.3 Co-existence studies

Table 6.22.3-1 lists Band26+3.3-3.8GHz 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.22.3-1: Band 26 and Band n78 UL harmonics and IMD products

UE UL carriers	Fx_low	Fx_high	Fy_low	Fy_high
UL frequency (MHz)	814	849	3300	3800
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1628	1698	6600	7600
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2442	2547	9900	11400
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	3256	3396	13200	15200
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	4070	4245	16500	19000
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	2451	2986	4114	4649
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)	2172	1602	5751	6786
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)	4928	5498	7414	8449
Two-tone 3rd order IMD products (with maximum channel bandwidth)	|fx_low – fy_BWmax|	|fx_high + fy_BW max|	|fx_low – fy_BW max|	|fx_high + fy_BW max|
IMD frequency limits (MHz)	714	949	3280	3820
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)	1358	753	9051	10586
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	4902	5972		
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)	5742	6347	10714	12249
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	8228	9298		
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)	14386	12351	96	544
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)	9772	8202	4053	5158
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)	14014	16049	6556	7196
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)	11528	13098	9042	10147

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Based on the table, 4th order harmonic and 3rd, 4th order IMD may fall into own Rx of band 26, and 3rd order IMD may fall into own Rx of NR band.

It should be noted that IMD will not be an issue for NR band (no self-interference) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.22.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.22.3-2: Band 26 and Band n78 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591			
Galileo	1559	-	1591			
GLONASS	1591	-	1610			IMD3
GPS	1563	-	1587			
ISM band (2.4GHz)	2400	-	2483.5		US/Europe	3rd harmonic, IMD2
	2400	-	2494		Asia	3rd harmonic, IMD2
ISM band (5GHz)	5150	-	5925		US	IMD3, IMD4, IMD5
	5150	-	5350		Europe	IMD3, IMD4, IMD5
	5470	-	5725			IMD3, IMD4
	5150	-	5825		Asia	IMD3, IMD4, IMD5

Table 6.22.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.22.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_26A-n78A	E-UTRA Band 1, 3, 11, 21, 28, 34, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	
	NR Band n257	26500	-	29500	[-5]	100	

6.22.4 ΔTIB and ΔRIB values

For DC_26A-n78A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.22.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_26A-n78A	26	0.3
	n78	0.8

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Table 6.22.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_26A-n78A	26	0
	n78	0.5

6.22.5 MSD

Table 6.22.5-1 lists the MSD due to 4th harmonic required for the dual connectivity configuration.

Table 6.22.5-1: MSD due to 4th harmonic for DC_26A-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
26	n78[1,2]		10.8	9.1	8		6				

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 4th 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 $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.4 \rfloor 0.1$ in MHz and $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$ 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 6.22.5-2 lists the UL configuration for the EN-DC configuration DC_26A-n78A.

Table 6.22.5-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for EN-DC in NR 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
26	n78	8	16	25	25[1], 25[2]						

NOTE 1: The configuration is used for measurement of MSD for NR channel bandwidth of 20MHz.
NOTE 2: The configuration is used for measurement of MSD for NR channel bandwidth of 40MHz.

Table 6.22.5-3 lists the MSD required for the dual connectivity configuration.

Table 6.22.5-3: MSD due to IMD issue for DC_26A-n78A

E-UTRA Band / Channel bandwidth / N_{RB} / Duplex mode								Source of IMD
EUTRA/NR DC Configuration	EUTRA/NR band	UL F_c (MHz)	UL/DL BW (MHz)	UL C_{LRB}	DL F_c (MHz)	MSD (dB)	Duplex mode	
DC_26A-n78A	26	836.5	5	25	881.5	11.1	FDD	IMD4
	n78	3390	10	50	3390	N/A	TDD	N/A

6.22.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.22.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.22.6-1.

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Table 6.22.6-1: Band 26 and Band n78 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_26A_n78A	26	a	-3	b	-1	4	26	IMD
	n78	c	1	d	0			
DC_26A_n78A	26	a	4	b	0	4	n78	Harmonic
	n78	c	0	d	-1			

Equations (1) and (2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.22.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (2)$$

Formula (3-1) and (3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (3\text{-}2)$$

6.23 DC_26A-n79A

6.23.1 Operating bands for DC

Table 6.23.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band BS receive / UE transmit F_{UL_low} – F_{UL_high}	Downlink (DL) band BS transmit / UE receive F_{DL_low} – F_{DL_high}	Duplex mode
DC_26A-n79A	26	814 MHz – 849 MHz	859 MHz – 894 MHz	FDD
	n79	4400 MHz – 5000 MHz	4400 MHz – 5000 MHz	TDD

6.23.2 Channel bandwidths per operating band for DC

Table 6.23.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_26A-n79A	26	15	Yes	Yes	Yes							115
	n79	15					Yes	Yes				
		30					Yes	Yes	Yes	Yes	Yes	
		60					Yes	Yes	Yes	Yes	Yes	

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6.23.3 Co-existence studies

Table 6.23.3-1 lists Band26+4.4-5GHz 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.23.3-1: Band 26 and Band n79 UL harmonics and IMD products

UE UL carriers	Fx_low	Fx_high	Fy_low	Fy_high
UL frequency (MHz)	814	849	4400	5000
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1628	1698	8800	10000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2442	2547	13200	15000
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	3551	4186	5214	5849
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)	3372	2702	7951	9186
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)	6028	6698	9614	10849
Two-tone 3rd order IMD products (with maximum channel bandwidth)	|f1_low – f2_BWmax|	|f1_high + f2_BW max|	|f2_low – f1_BW max|	|f2_high + f1_BW max|
IMD frequency limits (MHz)	714	949	4380	5020
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)	2558	1853	12351	14186
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	7102	8372		
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)	6842	7547	14014	15849
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	10428	11698		
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)	19186	16751	1004	1744
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)	13372	11502	6253	7558
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)	18414	20849	7656	8396
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)	14828	16698	11242	12547

Based on the table, 3rd order IMD may fall into own Rx of band 26, and 3rd order IMD may fall into own Rx of NR band.

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It should be noted that IMD will not be an issue for NR band (no self-interference) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.23.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.23.3-2: Band 26 and Band n79 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591			IMD5
Galileo	1559	-	1591			IMD5
GLONASS	1591	-	1610			IMD5
GPS	1563	-	1587			IMD5
ISM band (2.4GHz)	2400	-	2483.5		US/Europe	3rd harmonic, IMD4
	2400	-	2494		Asia	3rd harmonic, IMD4
ISM band (5GHz)	5150	-	5925		US	IMD2
	5150	-	5350		Europe	IMD2
	5470	-	5725			IMD2
	5150	-	5825		Asia	IMD2

Table 6.23.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.23.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_26A-n79A	E-UTRA Band 1, 3, 11, 21, 28, 34, 42, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	
	NR Band n257	26500	-	29500	[-5]	100	

6.23.4 ΔTIB and ΔRIB values

For DC_26A-n79A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.23.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_26A-n79A	26	0
	n79	0

Table 6.23.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_26A-n79A	26	0
	n79	0

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6.23.5 MSD

Table 6.23.5-1 gives the MSD values for DC_26A-n79A due to harmonic mixing.

Table 6.23.5-1 MSD due to harmonic mixing for DC_26A-n79A

MSD due to harmonic mixing 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
n79	26	27	24	22.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NOTE 1: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (higher) band for which the mixing product due to harmonic of victim (lower) band LO with leakage of aggressor (higher) band is within the downlink transmission bandwidth of a victim (lower) band.											
NOTE 2: The requirements should be verified for DL EARFCN of the victim (lower) band (superscript LB) such that $f_{DL}^{LB} = \lfloor f_{UL}^{HB} / 0.5 \rfloor 0.1$ in MHz and $F_{DL\_low}^{LB} + BW_{Channel}^{LB}/2 \le f_{DL}^{LB} \le F_{DL\_high}^{LB} - BW_{Channel}^{LB}/2$ with f_{DL}^{LB} carrier frequency in the victim (lower) band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the lower band.											

Uplink configuration in Table shall be considered for the harmonic mixing test for DC_26A-n79A. The purpose is to verify the REFSENS degradation of the low band, therefore, there is no need to configure all the CBWs for the NR band. For larger SCS for the NR band, the RB allocation should be as close as the bandwidth for15kHz SCS.

Table 6.23.5-2 Uplink configuration for the high band (exceptions) for NR

NR Band / Channel bandwidth of the high band / N_{RB}												
LTE-NR DC band combination	UL band	SCS	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz
DC_26-n79	n79	15	25	50	75							
NOTE 1: RB allocations in this table are corresponding to channel bandwidth of Band 26.												

6.23.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.23.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.23.6-1.

Table 6.23.6-1: Band 26 and Band n79 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_26A_n79A	26	a	0	b	-5	5	26	Harmonic mixing
	n79	c	1	d	0			
DC_26A_n79A	26	a	6	b	0	6	n79	Harmonic
	n79	c	0	d	-1			

Equations (6.23.6.1) and (6.23.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.23.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.23.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.23.6.2)$$

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Formula (3-1) and (3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.23.6.3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.23.6.3\text{-}2)$$

6.24 DC_26A-n257A

6.24.1 Operating bands for DC

Table 6.24.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band BS receive / UE transmit F_{UL_low} – F_{UL_high}	Downlink (DL) band BS transmit / UE receive F_{DL_low} – F_{DL_high}	Duplex mode
DC_26A_n257	26	814 MHz – 849 MHz	859 MHz – 894 MHz	FDD
	n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD

6.24.2 Channel bandwidths per operating band for DC

Table 6.24.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	[50 MHz]	100 MHz	200 MHz	400 MHz	Maximum aggregated bandwidth [MHz]
DC_26A_n257	26	15	Yes	Yes	Yes						415
	n257	60					Yes	Yes	Yes		
		120					Yes	Yes	Yes	Yes	

6.24.3 Co-existence studies

Table 6.24.3-1 lists Band26+26.5-29.5GHz 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.24.3-1: Band 26 and Band n257 UL harmonics and IMD products

UE UL carriers	Fx_low	Fx_high	Fy_low	Fy_high
UL frequency (MHz)	814	849	26500	29500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1628	1698	53000	59000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2442	2547	79500	88500
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	25651	28686	27314	30349
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)	27872	24802	52151	58186

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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)	28128	31198	53814	59849
Two-tone 3rd order IMD products (with maximum channel bandwidth)	|fx_low – fy_BWmax|	|fx_high + fy_BW max|	|fy_low – fx_BW max|	|fy_high + fx_BW max|
IMD frequency limits (MHz)	414	1249	26480	29520
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)	27058	23953	78651	87686
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	51302	57372		
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)	28942	32047	80314	89349
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	54628	60698		
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)	117186	105151	23104	26244
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)	86872	77802	50453	56558
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)	106814	118849	29756	32896
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)	81128	90198	55442	61547

Based on the table, 3rd order IMD may fall into own Rx of band 26, and 2nd, 3rd and 4th order IMD may fall into own Rx of NR band.

It should be noted that IMD will not be an issue for NR band (no self-interference) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.24.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.24.3-2: Band 26 and Band n257 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591			
Galileo	1559	-	1591			
GLONASS	1591	-	1610			
GPS	1563	-	1587			
ISM band (2.4GHz)	2400	-	2483.5	YES	US/Europe	3rd harmonic
	2400	-	2494	YES	Asia	3rd harmonic
ISM band (5GHz)	5150	-	5925		US	
	5150	-	5350		Europe	
	5470	-	5725			
	5150	-	5825		Asia	

Table 6.24.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.24.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_26A-n257A	E-UTRA Band 1, 3, 11, 21, 28, 34, 42, 65, n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	

6.24.4 ΔTIB and ΔRIB values

For DC_26A_n257, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.24.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_26A_n257	26	0
	n257	0

Table 6.24.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_26A_n257	26	0
	n257	0

6.24.5 MSD

There is no MSD issue for this DC configuration.

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6.25 DC_28A-n77

6.25.1 Operating bands for DC

Table 6.25.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_28A-n77	28	703 MHz – 748 MHz	758 MHz – 803 MHz	FDD
	n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	TDD

6.25.2 Channel bandwidths per operating band for DC

Table 6.25.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_28A-n77A	28	15	Yes	Yes	Yes	Yes						120
	n77	15		Yes	Yes	Yes	Yes	Yes				
		30		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
		60		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
DC_28A-n77C	28	15	Yes	Yes	Yes	Yes						220
	n77	See CA_n77C in Table 5.5A.1-1 in TS 38.101-1 [3]										

6.25.3 Co-existence studies

For 2UL/2DL UE coexistence study 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order intermodulation products were calculated and presented in Table 6.25.3-1

Table 6.25.3-1: Harmonic and IMD analysis

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	703	748	3300	4200
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1406	1496	6600	8400
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2109	2244	9900	12600
Two tone 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|

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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 – fy_high|	|3*fx_high – fy_low|	|3*fy_low – fx_high|	|3*fy_high – fx_low|
IMD frequency limits (MHz)	2091	1056	9152	11897
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)	5409	6444	10603	13348
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)	6994	5104	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	|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_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	|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 the table 6.25.3-1, the 5th order IMD products may fall in the own Rx of Band 28. The 2nd order IMD products may fall in the own Rx of NR Band (3300-4200MHz).In addition, 2nd and 3rd order harmonic and 2nd, 3rd, 4th and 5th IMD products may also fall into Rx frequencies of bands 1-14, 17-21, 23-42, and 44-70.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.25.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.25.3-2: 2UL Band 28 +Band n77 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD 4
Galileo	1559	-	1591	Yes		IMD 4
GLONASS	1591	-	1610	Yes		IMD 4
GPS	1563	-	1587	Yes		IMD 4
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD3
	2400	-	2494	Yes	Asia	IMD3
ISM band (5GHz)	5150	-	5925	Yes	US	IMD3, 4, 5
	5150	-	5350	Yes	Europe	IMD3, 4, 5
	5470	-	5725	Yes		IMD3, 4, 5
	5150	-	5825	Yes	Asia	IMD3, 4, 5

Table 6.25.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.25.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_28A-n77A	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 1, 65	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception
	E-UTRA Band 1	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception of -36 dBm/MHz for 718-748 MHz
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception of -38 dBm/MHz for 718-748 MHz
	Frequency range	758	-	773	-32	1	
	Frequency range	773	-	803	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	NR Band n257	26500	-	29500	[-5]	100	

6.25.4 ΔT_{IB} and ΔR_{IB} values

Table 6.25.4-2: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_28A-n77	28	0.5
	n77	0.8
NOTE 1: HTF is assumed for Band 28.		

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Table 6.25.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_28A-n77	28	0.2
	n77	0.5
NOTE 1: HTF is assumed for Band 28.		

6.25.5 MSD

Table 6.25.5-1: Reference sensitivity for the dual connectivity configuration for 5th harmonic

EUTRA/NR DC Configuration	EUTRA/NR band	5 MHz	10 MHz	15 MHz	20 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Duplex mode
CA_28A-n77A	28	-98.3	-95.3	-93.5	-90.8						FDD
	n77		[-85.4]	[-85.1]	[-84.9]	[-84.9]	[-84.9]	[-84.9]	[-84.9]	[-84.9]	TDD

Table 6.25.5-2: MSD for the dual connectivity configuration for IMD5

E-UTRA 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_28A-n77A	28	705.5	5	25	760.5	[5.5]	FDD	IMD5
	n77	3582.5	10	25	3582.5	N/A	TDD	N/A

Table 6.25.5-3: MSD for the DC configuration for 5th harmonic mixing

MSD due to harmonic mixing 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
n77	28	28	25	23.2	22	N/A	N/A	N/A	N/A	N/A	N/A

NOTE 1: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (higher) band for which the mixing product due to harmonic of victim (lower) band LO with leakage of aggressor (higher) band is within the downlink transmission bandwidth of a victim (lower) band.

NOTE 2: The requirements should be verified for DL EARFCN of the victim (lower) band (superscript LB) such that $f_{DL}^{LB} = \lfloor f_{UL}^{HB} / 0.5 \rfloor 0.1$ in MHz and $F_{DL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{DL}^{LB} \le F_{DL\_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{LB} carrier frequency in the victim (lower) band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the lower band.

Uplink configuration in Table shall be considered for the harmonic mixing test for DC_28-n77. The purpose is to verify the REFSENS degradation of the low band, therefore, there is no need to configure all the CBWs for the NR band. For larger SCS for the NR band, the RB allocation should be as close as the bandwidth for15kHz SCS.

Table 6.20.5-4 Uplink configuration for the high band (exceptions) for NR

NR Band / Channel bandwidth of the high band / N_{RB}												
LTE-NR DC band combination	UL band	SCS	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz
DC_28-n77	n77	15	25	50	75	100						
NOTE 1: RB allocations in this table are corresponding to channel bandwidth of Band 28.												

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6.25.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.25.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.25.6-1.

Table 6.25.6-1: Band 28 and Band n77 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_28A_n77A	28	a	-4	b	-1	5	28	IMD
	n77	c	1	d	0			
DC_28A_n77A	28	a	5	b	0	5	n77	Harmonic
	n77	c	0	d	-1			
DC_28A_n77A	28	a	0	b	-5	5	28	Harmonic mixing
	n77	c	1	d	0			

Equations (6.25.6.1) and (6.25.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.25.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.25.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.25.6.2)$$

Formula (3-1) and (3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.25.6.3\text{-}1)$$

$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.25.6.3\text{-}2)$$

6.26 DC_28A-n78

6.26.1 Operating bands for DC

Table 6.26.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band BS receive / UE transmit $F_{UL\_low} – F_{UL\_high}$	Downlink (DL) band BS transmit / UE receive $F_{DL\_low} – F_{DL\_high}$	Duplex mode
DC_28A-n78	28	703 MHz – 748 MHz	758 MHz – 803 MHz	FDD
	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD

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6.26.2 Channel bandwidths per operating band for DC

Table 6.26.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	**E-UTRA and NR 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]**
DC_28A-n78A	28	15	Yes	Yes	Yes	Yes						120
	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	
DC_28A-n78C	28	15	Yes	Yes	Yes	Yes						220
	n78	See CA_n78C in Table 5.5A.1-1 in TS 38.101-1 [3]										

6.26.3 Co-existence studies

For 2UL/2DL UE coexistence study 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order intermodulation products were calculated and presented in Table 6.26.3-1

Table 6.26.3-1: Harmonic and IMD analysis

UE UL carriers	**fx_low**	**fx_high**	**fy_low**	**fy_high**
UL frequency (MHz)	703	748	3300	3800
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1406	1496	6600	7600
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2109	2244	9900	11400
Two tone 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 – fy_high|	|3*fx_high – fy_low|	|3*fy_low – fx_high|	|3*fy_high – fx_low|
IMD frequency limits (MHz)	1691	1056	9152	10697
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)	5409	6044	10603	12148

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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)	6194	5104	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	|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_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	|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 the table 6.26.3-1, the 5 order IMD products may fall in the own Rx of Band 28. In addition, 2nd and 3rd order harmonic and 2nd, 3rd, 4th and 5th IMD products may also fall into Rx frequencies of bands 1-14, 17-21, 23-41 and 44-70.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.26.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.26.3-2: 2UL Band 28 +Band n78 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD 4
Galileo	1559	-	1591	Yes		IMD 4
GLONASS	1591	-	1610	Yes		IMD 4
GPS	1563	-	1587	Yes		IMD 4
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	Yes	US	IMD3, 4, 5
	5150	-	5350	Yes	Europe	IMD3, 4, 5
	5470	-	5725	Yes		IMD4, 5
	5150	-	5825	Yes	Asia	IMD3, 4, 5

Table 6.26.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.26.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission				
	Protected band	Frequency range (MHz)	Maximum Level (dBm)	MBW (MHz)	NOTE

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DC_28A-n78A	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 1, 65	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception
	E-UTRA Band 1	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception of -36 dBm/MHz for 718-748 MHz
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception of -38 dBm/MHz for 718-748 MHz
	Frequency range	758	-	773	-32	1	
	Frequency range	773	-	803	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	NR Band n257	26500	-	29500	[-5]	100	

6.26.4 ΔT_{IB} and ΔR_{IB} values

Table 6.26.4-2: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_28A-n78	28	0.5
	n78	0.8
NOTE 1: HTF is assumed for Band 28.		

Table 6.26.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_28A-n78	28	0.2
	n78	0.5
NOTE 1: HTF is assumed for Band 28.		

6.26.5 MSD

Table 6.26.5-1: Reference sensitivity for the dual connectivity configuration for 5th harmonic

Channel bandwidth											
EUTRA/NR DC Configuration	EUTRA/NR band	5 MHz	10 MHz	15 MHz	20 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Duplex mode
CA_28A-n78A	28	-98.3	-95.3	-93.5	-90.8						FDD
	n78		[-85.4]	[-85.1]	[-84.9]	[-84.9]	[-84.9]	[-84.9]	[-84.9]	[-84.9]	TDD

Table 6.25.5-2: MSD for the dual connectivity configuration for IMD5

E-UTRA 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_28A-n78A	28	705.5	5	25	760.5	[5.5]	FDD	IMD5
	n78	3582.5	10	25	3582.5	N/A	TDD	N/A

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6.26.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.26.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.26.6-1.

Table 6.26.6-1: Band 28 and Band n78 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_28A_n78A	28	a	-4	b	-1	5	28	IMD
	n78	c	1	d	0			
DC_28A_n78A	28	a	5	b	0	5	n78	Harmonic
	n78	c	0	d	-1			
DC_28A_n78A	28	a	0	b	-5	5	28	Harmonic mixing
	n78	c	1	d	0			

Equations (6.26.6.1) and (6.26.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.26.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.26.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.26.6.2)$$

Formula (6.26.6.3-1) and (6.26.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.26.6.3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.26.6.3\text{-}2)$$

6.27 DC_28A-n79

6.27.1 Operating bands for DC

Table 6.27.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_28A-n79	28	703 MHz – 748 MHz	758 MHz – 803 MHz	FDD
	n79	4400 MHz – 5000 MHz	4400 MHz – 5000 MHz	TDD

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6.27.2 Channel bandwidths per operating band for DC

Table 6.27.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	**E-UTRA and NR 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]**
DC_28A-n79A	28	15	Yes	Yes								110
	n79	15					Yes	Yes				
		30					Yes	Yes	Yes	Yes	Yes	
		60					Yes	Yes	Yes	Yes	Yes	
DC_28A-n79C	28	15	Yes	Yes								210
	n79	See CA_n79C in Table 5.5A.1-1 in TS 38.101-1 [3]										

6.27.3 Co-existence studies

Table 6.27.3-1 lists Band 28 +Band n79 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.27.3-1: Band 28 and Band n79 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	703	748	4400	5000
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1406	1496	8800	10000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2109	2244	13200	15000
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	3652	4297	5103	5748
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)	2904	3594	8052	9297
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)	5806	6496	9503	10748
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)	603	848	4390	5010
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)	2156	2891	12452	14297
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	7304	8594		
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)	6509	7244	13903	15748
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	10206	11496		
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)	16852	19297	1408	2188
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)	11704	13594	6556	7891
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)	18303	20748	7212	7992
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)	14606	16496	10909	12244

Based on Table 6.27.3-1;

- 2nd order harmonic may fall into Rx frequencies of bands 11, 21, 45
- 3rd order harmonic may fall into Rx frequencies of bands 1, 4, 10, 23, 65, 66
- 2nd order IMD may also fall into Rx frequencies of bands 43, 46, 48, n77 (3.3 – 4.2 GHz) and n78 (3.3 – 3.8 GHz)
- 3rd order IMD may also fall into own Rx of band 28 and Rx frequencies of bands12, 13, 14, 17, 20, 22, 29, 42, 44, 46, 47, 48, 67, 68, n77 (3.3 – 4.2 GHz) and n78 (3.3 – 3.8 GHz)
- 4th order IMD may also fall into Rx frequencies of bands 1, 7, 10, 23, 30, 38, 40, 41, 65, 66, 69
- 5th order IMD may also fall into Rx frequencies of bands 1, 2, 3, 4, 9, 10, 11, 21, 23, 24, 25, 33, 34, 35, 36, 37, 39, 45, 65, 66, 70

When 2UL inter-band DC UE is operating with other systems such as Wi-Fi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.27.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.27.3-2: 2UL Band 28 +Band n79 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD5
Galileo	1559	-	1591	Yes		IMD5
GLONASS	1591	-	1610	Yes		IMD5
GPS	1563	-	1587	Yes		IMD5
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD4
	2400	-	2494	Yes	Asia	IMD4
ISM band (5GHz)	5150	-	5925	Yes	US	IMD2, IMD3
	5150	-	5350	Yes	Europe	IMD2
	5470	-	5725	Yes		IMD2
	5150	-	5825	Yes	Asia	IMD2, IMD3

Table 6.27.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.27.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_28A-n79A	E-UTRA Band 3, 5, 8, 18, 19, 34, 39, 40, 41, 42	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 1, 65	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception
	E-UTRA Band 1	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception of -36 dBm/MHz for 718-748 MHz
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception of -38 dBm/MHz for 718-748 MHz
	Frequency range	758	-	773	-32	1	
	Frequency range	773	-	803	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	NR Band n257	26500	-	29500	[-5]	100	

6.27.4 ΔT_{IB} and ΔR_{IB} values

For DC_28A-n79, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.27.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_28A-n79	28	0
	n79	0

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Table 6.27.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_28A-n79	28	0
	n79	0

6.27.5 MSD

Even if HTF is implemented, little IL impact is expected considering that reported MSD in LTE Band 46 discussion is up to 8.8 dB. Therefore it is agreed to specify no MSD requirement for the 6th and 7th harmonics cases and not to assume additional IL i.e. ΔTib and ΔRib due to HTF.

6.27.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.27.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.27.6-1.

Table 6.27.6-1: Band 28 and Band n79 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_28A_n79A	28	a	6	b	0	6	n79	Harmonic
	n79	c	0	d	-1			
DC_28A_n79A	28	a	7	b	0	7	n79	Harmonic
	n79	c	0	d	-1			

Equations (6.27.6.1) and (6.27.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.27.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.27.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.27.6.2)$$

Formula (6.27.6.3-1) and (6.27.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.27.63\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.27.63\text{-}2)$$

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6.28 DC_41A-n257A

6.28.1 Operating bands for DC

Table 6.28.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_41A_n257	41	2496 MHz – 2690 MHz	2496 MHz – 2690 MHz	TDD
	n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD

6.28.2 Channel bandwidths per operating band for DC

Table 6.28.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	[50 MHz]	100 MHz	200 MHz	400 MHz	Maximum aggregated bandwidth [MHz]
DC_41A_n257	41	15	Yes	Yes	Yes	Yes					420
	n257	60					Yes	Yes	Yes		
		120					Yes	Yes	Yes	Yes	

6.28.3 Co-existence studies

Table 6.28.3-1 lists Band41+26.5-29.5GHz 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.28.3-1: Band 41 and Band n257 UL harmonics and IMD products

UE UL carriers	Fx_low	Fx_high	Fy_low	Fy_high
UL frequency (MHz)	2496	2690	26500	29500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	4992	5380	53000	59000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	7488	8070	79500	88500
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	23810	27004	28996	32190
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)	24508	21120	50310	56504
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)	31492	34880	55496	61690
Two-tone 3rd order IMD products (with maximum channel bandwidth)	|fx_low – fy_BWmax|	|fx_high + fy_BW max|	|fy_low – fx_BW max|	|fy_high + fx_BW max|
IMD frequency limits (MHz)	2096	3090	26480	29520
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|

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IMD frequency limits (MHz)	22012	18430	76810	86004
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	47620	54008		
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)	33988	37570	81996	91190
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	57992	64380		
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)	115504	103310	15740	19516
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)	83508	74120	44930	51512
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)	108496	120690	36484	40260
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)	84492	93880	60488	67070

Based on the table, 3rd order IMD may fall into own Rx of band 41, and 2nd and 3rd order IMD may fall into own Rx of NR band.

It should be noted that IMD will not be an issue for NR band (no self-interference) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.28.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.28.3-2: Band 41 and Band n257 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591			
Galileo	1559	-	1591			
GLONASS	1591	-	1610			
GPS	1563	-	1587			
ISM band (2.4GHz)	2400	-	2483.5	YES	US/Europe	IMD3
	2400	-	2494	YES	Asia	IMD3
ISM band (5GHz)	5150	-	5925	YES	US	2nd harmonic
	5150	-	5350	YES	Europe	2nd harmonic
	5470	-	5725			
	5150	-	5825	YES	Asia	2nd harmonic

Table 6.28.3-3 lists the protected bands required for the dual connectivity configuration.

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Table 6.28.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_41A-n257A	E-UTRA Band 1, 3, 5, 8, 9, 11, 18, 19, 21, 26, 28, 33, 34, 39, 40, 44, 45, 50, 51, 65, 74	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	1839.9		1879.9	-50	1	
	Frequency range	1884.5		1915.7	-41	0.3	PHS

6.28.4 ΔTIB and ΔRIB values

For DC_41A_n257, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.28.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_41A_n257	41	0
	n257	0

Table 6.28.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_41A_n257	41	0
	n257	0

6.28.5 MSD

There is no MSD issue for this DC configuration.

6.29 DC_42A-n77

6.29.1 Operating bands for DC

Table 6.29.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_42A-n77	42	3400 MHz – 3600 MHz	3400 MHz – 3600 MHz	TDD
	n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	

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6.29.2 Channel bandwidths per operating band for DC

Table 6.29.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	**E-UTRA and NR 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]**
DC_42A-n77A	42	15	Yes	Yes	Yes	Yes						120
	n77	15		Yes	Yes	Yes	Yes	Yes				
		30		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
		60		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
DC_42A-n77C	42	15	Yes	Yes	Yes	Yes						220
	n77	See CA_n77C in Table 5.5A.1-1 in TS 38.101-1 [3]										

6.29.3 Co-existence studies

Since simultaneous transmission of LTE Band 42 and NR Band n77 are not supported at least in Rel-15 timeframe, no co-existence studies are needed at this moment.

6.29.4 ΔT_{IB} and ΔR_{IB} values

For DC_42A-n77, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.29.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_42A-n77	42	0
	n77	0

Table 6.29.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_42A-n77	42	0
	n77	0

6.29.5 MSD

There is no MSD issue for this DC configuration based on the following conditions.

- LTE Band 42 and NR Band n77 are synchronized
- Simultaneous transmission of LTE Band 42 and NR Band n77 are not supported at least in Rel-15 timeframe

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6.30 DC_42A-n78

6.30.1 Operating bands for DC

Table 6.30.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_42A-n78	42	3400 MHz – 3600 MHz	3400 MHz – 3600 MHz	TDD
	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	

6.30.2 Channel bandwidths per operating band for DC

Table 6.30.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_42A-n78A	42	15	Yes	Yes	Yes	Yes						120
	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	
DC_42A-n78C	42	15	Yes	Yes	Yes	Yes						220
	n78	See CA_n78C in Table 5.5A.1-1 in TS 38.101-1 [3]										

6.30.3 Co-existence studies

Since simultaneous transmission of LTE Band 42 and NR Band n78 are not supported at least in Rel-15 timeframe, no co-existence studies are needed at this moment.

6.30.4 ΔT_{IB} and ΔR_{IB} values

For DC_42A-n78, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.30.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_42A-n78	42	0
	n78	0

Table 6.30.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_42A-n78	42	0
	n78	0

6.30.5 MSD

There is no MSD issue for this DC configuration based on the following conditions.

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- LTE Band 42 and NR Band n78 are synchronized
- Simultaneous transmission of LTE Band 42 and NR Band n78 are not supported at least in Rel-15 timeframe

6.31 DC_42A-n79

6.31.1 Operating bands for DC

Table 6.31.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_42A-n79	42	3400 MHz – 3600 MHz	3400 MHz – 3600 MHz	TDD
	n79	4400 MHz – 5000 MHz	4400 MHz – 5000 MHz	TDD

6.31.2 Channel bandwidths per operating band for DC

Table 6.31.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_42A-n79A	42	15	Yes	Yes	Yes	Yes						120
	n79	15					Yes	Yes				
		30					Yes	Yes	Yes	Yes	Yes	
		60					Yes	Yes	Yes	Yes	Yes	
DC_42A-n79C	42	15	Yes	Yes	Yes	Yes						220
	n79	See CA_n79C in Table 5.5A.1-1 in TS 38.101-1 [3]										

6.31.3 Co-existence studies

Table 6.31.3-1 lists Band 42 +Band n79 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.31.3-1: Band 42 and Band n79 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	3400	3600	4400	5000
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	6800	7200	8800	10000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	10200	10800	13200	15000
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	800	1600	7800	8600
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)	1800	2800	5200	6600
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)	11200	12200	12200	13600
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)	3300	3700	4380	5020
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)	5200	6400	9600	11600
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	1600	3200		
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)	14600	15800	16600	18600
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	15600	17200		
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)	14000	16600	8600	10000
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)	6000	8200	200	2000
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)	21000	23600	18000	19400
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)	20000	22200	19000	20800

Based on Table 6.31.3-1;

- 2nd order IMD may also fall into Rx frequencies of bands 5, 6, 8, 11, 18, 19, 20, 21, 24, 26, 27, 28, 44, 45
- 3rd order IMD may also fall into Rx frequencies of bands1, 2, 3, 4, 7, 9, 10, 22, 23, 25, 30, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 46, 47, 48, 65, 66, 69, 70, n77 (3.3 – 4.2 GHz) and n78 (3.3 – 3.8 GHz)
- 4th order IMD may also fall into Rx frequencies of bands 1, 2, 3, 4, 7, 9, 10, 23, 25, 30, 33, 34, 35, 36, 37, 38, 39, 40, 41, 46, 47, 65, 66, 69, 70
- 5th order IMD may also fall into Rx frequencies of bands 2, 3, 5, 6, 8, 9, 11, 12, 13, 14, 17, 18, 19, 20, 21, 24, 25, 26, 27, 28, 29, 31, 33, 35, 36, 37, 39, 44, 45, 67, 68, 70

When 2UL inter-band DC UE is operating with other systems such as Wi-Fi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.31.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.31.3-2: 2UL Band 42 +Band n79 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD2, IMD5
Galileo	1559	-	1591	Yes		IMD2, IMD5
GLONASS	1591	-	1610	Yes		IMD2, IMD4, IMD5
GPS	1563	-	1587	Yes		IMD2, IMD5
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD3, IMD4
	2400	-	2494	Yes	Asia	IMD3, IMD4
ISM band (5GHz)	5150	-	5925	Yes	US	IMD3, IMD4
	5150	-	5350	Yes	Europe	IMD3, IMD4
	5470	-	5725	Yes		IMD3, IMD4
	5150	-	5825	Yes	Asia	IMD3, IMD4

Table 6.31.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.31.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_42A-n79A	E-UTRA Band 1, 3, 5, 8, 11, 18, 19, 21, 28, 34, 39, 40, 41, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	NR Band n257	26500	-	29500	[-25]	1	

6.31.4 ΔT_{IB} and ΔR_{IB} values

For DC_42A-n79, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.31.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_42A-n79	42	0
	n79	0

Table 6.31.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_42A-n79	42	0
	n79	0

6.31.5 MSD

There is no MSD issue for this DC configuration based on the followings.

- IMD doesn't matter since both bands are TDD

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- Frequency proximity doesn't matter since there is a large frequency gap of 800 MHz between two bands

6.32 DC_20A-n28A

6.32.1 Operating bands for DC

Table 6.32.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_20A-n28A	20	832 MHz – 862 MHz	791 MHz – 821 MHz	FDD
	28	703 MHz – 733 MHz	758 MHz – 788 MHz	

NOTE: Band 28 is defined from UL 703 to 748 MHz and DL 758 to 803 MHz

6.32.2 Channel bandwidths per operating band for DC

Table 6.32.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_20A-n28A	20	15	Yes	Yes	Yes	Yes						40
	28	15	Yes	Yes	Yes	Yes						
		30	Yes	Yes	Yes	Yes						
		60										

6.32.3 Co-existence studies

Tables 6.32.3-1, Band 20A+Band n28A 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.32.3-1: Band 20 and Band n28 (lower duplex) UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fn_low	fn_high
UL frequency (MHz)	832	862	703	733
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fn_low	2* fn_high
2nd harmonics frequency limits (MHz)	1664 – 1724		1406 – 1466	
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fn_low	3* fn_high
3rd harmonics frequency limits (MHz)	2496 – 2586		2109 – 2199	
2nd order IMD products	|fn_low – fx_high|	|fn_high – fx_low|	|fn_low + fx_low|	|fn_high + fx_high|
IMD frequency limits (MHz)	99 – 159		1535 – 1595	
Two-tone 3rd order IMD products	|2*fx_low – fn_high|	|2*fx_high – fn_low|	|2*fn_low – fx_high|	|2*fn_high – fx_low|
IMD frequency limits (MHz)	931 – 1021		544 – 634	
Two-tone 3rd order IMD products	|2*fx_low + fn_low|	|2*fx_high + fn_high|	|2*fn_low + fx_low|	|2*fn_high + fx_high|
IMD frequency limits (MHz)	2367 – 2472		2238 – 2358	
Two-tone 3rd order IMD products	(fx_low – max BW fn)	(fx_high + max BW fn)	(fn_low – max BW fx)	(fn_high + max BW fx)
IMD frequency limits (MHz)	812 – 882		683 – 753	
Two-tone 4th order IMD products	|3*fx_low –1* fn_high|	|3*fx_high – 1*fn_low|	|3*fn_low – 1*fx_high|	|3*fn_high – 1*fx_low|
IMD frequency limits (MHz)	1763 – 1883		1247 – 1367	
Two-tone 4th order IMD products	|2*fx_low –2* fn_high|	|2*fx_high –2* fn_low|		
IMD frequency limits (MHz)	198 – 318			
Two-tone 4th order IMD products	|3*fx_low +1* fn_low|	|3*fx_high + 1*fn_high|	|3*fn_low + 1*fx_low|	|3*fn_high + 1*fx_high|
IMD frequency limits (MHz)	3199 – 3319		2941 – 3061	
Two-tone 4th order IMD products	|2*fx_low +2* fn_low|	|2*fx_high +2* fn_high|		
IMD frequency limits (MHz)	3070 – 3190			
Two-tone 5th order IMD products	|fx_low – 4*fn_high|	|fx_high – 4*fn_low|	|fn_low – 4*fx_high|	|fn_high – 4*fx_low|
IMD frequency limits (MHz)	1950 – 2100		2595– 2745	
Two-tone 5th order IMD products	|2*fx_low - 3*fn_high|	|2*fx_high - 3*fn_low|	|2*fn_low - 3*fx_high|	|2*fn_high - 3*fx_low|
IMD frequency limits (MHz)	385 – 535		1030 – 1180	
Two-tone 5th order IMD products	|fx_low + 4*fn_low|	|fx_high + 4*fn_high|	|fn_low + 4*fx_low|	|fn_high + 4*fx_high|
IMD frequency limits (MHz)	3644 – 3794		4031 – 4181	
Two-tone 5th order IMD products	|2*fx_low + 3*fn_low|	|2*fx_high + 3*fn_high|	|2*fn_low + 3*fx_low|	|2*fn_high + 3*fx_high|
IMD frequency limits (MHz)	3373 – 3923		3902 – 4052	

Based on Table 6.32.3-1,

- 2nd order harmonics may fall into Rx frequencies of Band 11, 21, 32, 45
- 3rd order harmonics may fall into Rx frequencies of Band 1, 4, 10, 23, 38, 41, 65, 66, and 69
- 2nd order IMD may fall into Rx frequencies of Band 24
- 3rd order IMD may fall into Rx frequencies of Band 5, 8, 12, 13, 17, 18, 20, 26, 27, 29, 30, 40, 44, 67 and 68
- 4th order IMD may fall into Rx frequencies of Band 3, 9, 35, 39, n77, and n78
- 5th order IMD may fall into Rx frequencies of Band 1, 2, 4, 7, 10, 25, 31, 34, 36, 38, 41, 43, 48, 65, 66, 69, 70, n77, and n78

When 2UL inter-band DC UE is operating with other systems such as Wi-Fi, Bluetooth and GNSS; the harmonics and intermodulation products can have impact on these systems. Table 6.X.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.32.3-2: 2UL Band 20 + Band n28 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD2
Galileo	1559	-	1591	Yes		IMD2
GLONASS	1591	-	1610	Yes		IMD2
GPS	1563	-	1587	Yes		IMD2
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD3
	2400	-	2494	Yes	Asia	IMD3
ISM band (5GHz)	5150	-	5925	No	US	-
	5150	-	5350	No	Europe	-
	5470	-	5725	No		-
	5150	-	5825	No	Asia	-

Table 6.32.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.32.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_20A-n28A	E-UTRA Band 1, 3, 7, 8, 22, 31, 32, 34, 38, 42, 43, 65, 75, 76	F_{DL_low}	-	F_{DL_high}	-50	1	

6.32.4 ΔT_{IB} and ΔR_{IB} values

For DC_20A-n28A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.32.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_20A-n28A	20	0.5
	n28	0.5

Table 6.32.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_20A-n28A	20	0
	n28	0

6.32.5 MSD

No MSD is required.

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6.33 DC_39A-n78A

6.33.1 Operating bands for DC

Table 6.33.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band	Downlink (DL) band	Duplex mode
		BS receive / UE transmit	BS transmit / UE receive	
		FUL_low – FUL_high	FDL_low – FDL_high	
DC_39A-n78A	39	1880 MHz – 1920 MHz	1880 MHz – 1920 MHz	TDD
	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD

6.33.2 Channel bandwidths per operating band for DC

Table 6.33.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_39A-n78A	39	15	Yes	Yes	Yes	Yes						120
	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	

6.33.3 Co-existence studies

Table 6.33.3-1 lists Band 39+Band n78 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.33.3-1: Band 39 and Band n78 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1880	1920	3300	3800
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3760–3840		6600–7600	
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5640–5760		9900–11400	
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	1380–1920		5180–5720	
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)	40–540		4680–5720	
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)	7060–7640		8480–9520	
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)	1780–2020		3285–3815	
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)	1840–2460		7980–9520	
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	2760–3840			
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)	8940–9560		11780–13320	
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	10360–11440			
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)	11280–13320		3720–4380	
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)	6060–7640		840–1960	
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)	15080–17120		10820–11480	
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)	13660–15240		12240–13360	

Based on Table 6.33.3-1,

- The 2th order harmonic of Band 39 may fall into Band n78. However, this band combination will only be used in China and the impacted frequency range 3760-3840MHz will not be allocated to IMT in China. So the 2nd harmonic issue will not be a problem for this combination.

- The 3rd 4th and 5th order IMD product may also fall into Band n78. However IMD will not be an issue for Band n78 (no self-interference for the TDD band) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.33.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.33.3-2: Band 39 and Band n78 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD5
Galileo	1559	-	1591	Yes		IMD5
GLONASS	1591	-	1610	Yes		IMD5
GPS	1563	-	1587	Yes		IMD5
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD4
	2400	-	2494	Yes	Asia	IMD4
ISM band (5GHz)	5150	-	5925	Yes	US	3rd harmonic IMD3
	5150	-	5350	Yes	Europe	IMD3
	5470	-	5725	Yes		3rd harmonic IMD3
	5150	-	5825	Yes	Asia	3rd harmonic IMD3

Table 6.33.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.33.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_39A-n78A	E-UTRA Band 1, 8, 34, 40, 41, 44, 45 or NR Band n1, n8, n34, n40, n41, n79	FDL_low	-	FDL_high	-50	1	
	Frequency range	1805	-	1855	-40	1	N
	Frequency range	1855	-	1880	-15.5	5	N
	NR Band n258	FDL_low	-	FDL_high	[-5]	100	
NOTE N: 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.							

6.33.4 ΔTIB and ΔRIB values

For DC_39A-n78A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in Table 6.33.4-1 Table 6.33.4-2.

Table 6.33.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_39A-n78A	39	0.3
	n78	0.8

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Table 6.33.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_39A-n78A	39	0
	n78	0.5

6.33.5 MSD

According to the interference analysis, only harmonic issue in asynchronous operation may be a problem for this band combination. However, the harmonic issue only impacts the frequency range 3760-3800MHz in Band n78. According to the spectrum situation in China where this combination is applicable, only the frequency below 3600Mz is allocated to IMT and it is far from the impacted frequency range. So there is no harmonic problem for this combination. No MSD needs to be specified for this combination. While reduced frequency range need to be reflected for the combination in TS 38.101-3 [5] Table 5.2B.3.1-1 by a note "The frequency range above 3600MHz in Band n78 is not used in this combination."

6.33.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.33.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.33.6-1.

Table 6.33.6-1: Band 39 and Band n78 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_39A_n78A	39	a	2	b	0	2	n78	Harmonic
	n78	c	0	d	-1			

Equations (6.33.6.1) and (6.33.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.33.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.33.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.33.6.2)$$

Formula (6.33.6.3-1) and (6.33.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.33.6.3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.33.6.3\text{-}2)$$

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6.34 DC_39A-n258A

6.34.1 Operating bands for DC

Table 6.34.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band	Downlink (DL) band	Duplex mode
		BS receive / UE transmit	BS transmit / UE receive	
		FUL_low – FUL_high	FDL_low – FDL_high	
DC_39A-n258A	39	1880 MHz – 1920 MHz	1880 MHz – 1920 MHz	TDD
	n258	24250 MHz – 27500 MHz	24250 MHz – 27500 MHz	TDD

6.34.2 Channel bandwidths per operating band for DC

Table 6.34.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	[50 MHz]	100 MHz	200 MHz	400 MHz	Maximum aggregated bandwidth [MHz]
DC_39A_n257	39	15	Yes	Yes	Yes	Yes					420
	n258	60					Yes	Yes	Yes		
		120					Yes	Yes	Yes	Yes	

6.34.3 Co-existence studies

Table 6.34.3-1 lists Band 39+Band n258 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.34.3-1: Band 39 and Band n258 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1880	1920	24250	27500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3760–3840		48500–55000	
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5640–5760		72750–82500	
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	22330–25620		26130–29420	
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)	20410–23740		46580–53120	
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)	28010–31340		50380–56920	
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)	1680–2120		24235–27515	
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)	21860–18490		70830–80620	
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	51240–44660			
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)	29890–33260		74630–84420	
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	52260–58840			
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)	108120–95080		16570–19980	
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)	78740–68910		42740–49360	
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)	98880–111920		31770–35180	
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)	76510–86340		54140–60760	

Based on Table 6.34.3-1, 3rd IMD product may fall in to Band 39. 2nd 3rd order IMD product may also fall into Band n258. It should be noted that IMD will not be an issue (no self-interference for the TDD band) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.34.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.34.3-2: Band 39 and Band n258 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	

Table 6.34.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.34.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_39A-n258A	Band 1, 8, 34, 40, 41, 44, 45 or NR Band n1, n8, n34, n40, n41, n78, n79	FDL_low	-	FDL_high	-50	1	
	Frequency range	1805	-	1855	-40	1	N
	Frequency range	1855	-	1880	-15.5	5	N
NOTE N: 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.							

6.34.4 ΔTIB and ΔRIB values

For DC_39A_n258A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.34.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_39A_n258	39	0
	n258	0

Table 6.34.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_39A_n258	39	0
	N258	0

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6.34.5 MSD

No IMD issue is identified.

6.35 DC_1A-n257

6.35.1 Operating bands for DC

Table 6.35.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_1A_n257	1	1920 MHz – 1980 MHz	2110 MHz – 2170 MHz	FDD
	n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD

6.35.2 Channel bandwidths per operating band for DC

Table 6.35.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	[50 MHz]	100 MHz	200 MHz	400 MHz	Maximum aggregated bandwidth [MHz]
DC_1A_n257A	1	15	Yes	Yes	Yes	Yes					420
	n257	60					Yes	Yes	Yes		
		120					Yes	Yes	Yes	Yes	
DC_1A_n257D	1	15	Yes	Yes	Yes	Yes					420
	n257	See CA_n257D in Table 5.5A1-2 in TS 38.101-2 [4]									
DC_1A_n257E	1	15	Yes	Yes	Yes	Yes					620
	n257	See CA_n257E in Table 5.5A1-2 in TS 38.101-2 [4]									
DC_1A_n257F	1	15	Yes	Yes	Yes	Yes					820
	n257	See CA_n257F in Table 5.5A1-2 in TS 38.101-2 [4]									

6.35.3 Co-existence studies

Table 6.35.3-1 lists Band 1 +Band n257 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.35.3-1: Band 1 and Band n257 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1920	1980	26500	29500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3840	3960	53000	59000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5760	5940	79500	88500
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	24520	27580	28420	31480
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)	22540	25660	51020	57080
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)	30340	33460	54920	60980
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)	1520	2380	26480	29520
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)	20560	23740	77520	86580
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	49040	55160		
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)	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)	104020	116080	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)	75540	84660	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

Based on Table 6.35.3-1;

- 2nd order harmonic may fall into Rx frequency of band n77
- 3rd order harmonic may fall into Rx frequencies of bands 46 and 47
- 2nd order IMD may also fall into Rx frequencies of bands n257 and n258
- 3rd order IMD may also fall into Rx frequencies of bands 1, 2, 3, 4, 9, 10, 23, 24, 25, 30, 33, 34, 35, 36, 37, 39, 40, 65, 66, 70, n257 and n258

When 2UL inter-band DC UE is operating with other systems such as Wi-Fi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.35.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.35.3-2: 2UL Band 1 +Band n257 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD3
Galileo	1559	-	1591	Yes		IMD3
GLONASS	1591	-	1610	Yes		IMD3
GPS	1563	-	1587	Yes		IMD3
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	Yes	US	Harmonic3
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	Yes	Asia	Harmonic3

Table 6.35.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.35.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_1A-n257A	E-UTRA Band 1, 3, 5, 7, 8, 11, 18, 19, 21, 26, 28, 34, 40, 41, 42, 65, n77, n78, n79	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

6.35.4 ΔT_{IB} and ΔR_{IB} values

For DC_1A_n257, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.35.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_1A_n257	1	0
	n257	0

Table 6.35.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_1A_n257	1	0
	n257	0

6.35.5 MSD

No IMD issues are expected for DC configuration between the LTE bands below 6GHz and FR2 NR band. Furthermore, up to 7th order harmonics have no impact to Rx frequency of both LTE and NR bands.

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6.36 DC_3A-n257

6.36.1 Operating bands for DC

Table 6.36.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_3A_n257	3	1710 MHz – 1785MHz	1805MHz – 1880MHz	FDD
	n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD

6.36.2 Channel bandwidths per operating band for DC

Table 6.36.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	[50 MHz]	100 MHz	200 MHz	400 MHz	Maximum aggregated bandwidth [MHz]
DC_3A_n257A	3	15	Yes	Yes	Yes	Yes					420
	n257	60					Yes	Yes	Yes		
		120					Yes	Yes	Yes	Yes	
DC_3A_n257D	3	15	Yes	Yes	Yes	Yes					420
	n257	See CA_n257D in Table 5.5A1-2 in TS 38.101-2 [4]									
DC_3A_n257E	3	15	Yes	Yes	Yes	Yes					620
	n257	See CA_n257E in Table 5.5A1-2 in TS 38.101-2 [4]									
DC_3A_n257F	3	15	Yes	Yes	Yes	Yes					820
	n257	See CA_n257F in Table 5.5A1-2 in TS 38.101-2 [4]									

6.36.3 Co-existence studies

Table 6.36.3-1 lists Band 3 +Band n257 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.36.3-1: Band 3 and Band n257 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1710	1785	26500	29500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3420	3570	53000	59000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5130	5355	79500	88500
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)	22930	26080	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 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)	1310	2185	26480	29520
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)	21145	24370	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)	104215	116290	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)	75930	85080	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 6.36.3-1;

- 2nd order harmonic may fall into Rx frequency of band 22, 42, 48, n77 and n78
- 3rd order harmonic may fall into Rx frequencies of bands 46
- 2nd order IMD may also fall into Rx frequencies of bands n257 and n258
- 3rd order IMD may also fall into Rx frequencies of bands 1, 2, 3, 4, 9, 10, 11, 21, 23, 24, 25, 33, 34, 35, 36, 37, 39, 45, 65, 66, 70, n257 and n258
- 4th order IMD may also fall into Rx frequencies of bands n258

When 2UL inter-band DC UE is operating with other systems such as Wi-Fi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.36.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.36.3-2: 2UL Band 3 +Band n257 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	Yes	US	Harmonic3
	5150	-	5350	Yes	Europe	Harmonic3
	5470	-	5725	No		
	5150	-	5825	Yes	Asia	Harmonic3

Table 6.36.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.36.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_3A-n257A	E-UTRA Band 1, 3, 5, 7, 8, 11, 18, 19, 21, 26, 28, 34, 39, 40, 41, 65, n79	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 42, n77, n78	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS

6.36.4 ΔT_{IB} and ΔR_{IB} values

For DC_3A_n257, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.36.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_3A_n257	3	0
	n257	0

Table 6.36.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_3A_n257	3	0
	n257	0

6.36.5 MSD

No IMD issues are expected for DC configuration between the LTE bands below 6GHz and FR2 NR band. Furthermore, up to 7th order harmonics have no impact to Rx frequency of both LTE and NR bands.

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6.37 DC_3A_n258A

6.37.1 Operating bands for DC

Table 6.37.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_3A_n258A	3	1710 MHz – 1785 MHz	1805 MHz – 1880 MHz	FDD
	n258	24.25 GHz – 27.5 GHz	24.25 GHz – 27.5 GHz	TDD

6.37.2 Channel bandwidths per operating band for DC

Table 6.37.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and 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]
DC_3A_n258A	3	15	Yes	Yes	Yes	Yes								420
	n258	60						Yes			Yes	Yes		
		120						[Yes]			Yes	Yes	Yes	

6.37.3 Co-existence studies

Table 6.37.3-1 lists Band 3 +Band n258 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.37.3-1: Band 3 and Band n258 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1710	1785	24250	27500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3420	3570	48500	55000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5130	5355	72750	82500
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	22465	25790	25960	29285
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)	24080	20680	46715	53290
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)	27670	31070	50210	56785
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)	1310	2185	24230	27520
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)	22370	18895	70965	80790
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	51580	44930		
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)	29380	32855	74460	84285
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	51920	58570		
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)	108290	95215	17110	20660
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)	79080	69180	43145	49870
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)	98710	111785	31090	34640
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)	76170	86070	53630	60355

Based on Table 6.37.3-1;

- 2nd order IMD may fall into own Rx of Band n258 and Rx frequencies of band n257.
- 3rd order IMD may fall into own Rx of Band n258 and Rx frequencies of bands 1, 2, 3, 4, 9, 10, 11, 21, 23, 24, 25, 32, 33, 34, 37, 39, 45, 65, 66, 70 and n257.
- 5th order IMD may fall into Rx frequencies of band n259.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.37.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.37.3-2: 2UL Band 3 +Band n258 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD3
Galileo	1559	-	1591	Yes		IMD3
GLONASS	1591	-	1610	Yes		IMD3
GPS	1563	-	1587	Yes		IMD3
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	

Table 6.37.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.37.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_3A_n258A	E-UTRA Band 1, 3, 5, 7, 8, 11, 18, 19, 21, 26, 28, 34, 39, 40, 41, 65, n79	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 42, n77, n78	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS

6.37.4 ΔT_{IB} and ΔR_{IB} values

For DC_3A_n258A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.37.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_3A_n258A	3	0
	n258	0

Table 6.37.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_3A_n258A	3	TBD0
	n258	0

6.37.5 MSD

There is no MSD issue for this DC configuration.

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6.38 DC_5A_n257A

6.38.1 Operating bands for DC

Table 6.38.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_5A-n257A	5	824 MHz – 849 MHz	869 MHz – 894 MHz	FDD
	n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD

6.38.2 Channel bandwidths per operating band for DC

Table 6.38.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	50 MHz	100 MHz	[200 MHz]	400 MHz	Maximum aggregated bandwidth [MHz]
DC_5A-n257A	5	15	Yes	Yes							410
	n257	60					Yes	Yes	Yes		
		120					Yes	Yes	Yes	Yes	

6.38.3 Co-existence studies

Table 6.38.3-1 lists Band 5 +Band n257 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.38.3-1: Band 5 and Band n257 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	824	849	26500	29500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1648	1698	53000	59000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2472	2547	79500	88500
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	25651	28676	27324	30349
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)	27852	24802	52151	58176
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)	28148	31198	53824	59849
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)	424	1249	26490	29510
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)	27028	23953	78651	87676
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	57352	51302		
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)	28972	32047	80324	89349
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	54648	60698		
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)	117176	105151	23104	26204
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)	86852	77802	50453	56528
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)	106824	118849	29796	32896
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)	81148	90198	55472	61547

Based on Table 6.38.3-1;

- 3rd order harmonic may fall into Rx frequencies of band 41
- 2nd order IMD may also fall into own Rx of band n257 and Rx frequencies of band n258
- 3rd order IMD may also fall into own Rx of band n257 and Rx frequencies of band n258
- 4th order IMD may also fall into own Rx of band n257 and Rx frequencies of bands n258 and n259
- 5th order IMD may also fall into Rx frequencies of bands n258 and n259

The 2nd, 3rd and 4th IMD will be impact to the own received band n257. However, the NR TDD band has no impact from dual uplink transmission since there was no simultaneous Tx/Rx transmission in the band n257.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.38.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.38.3-2: 2UL Band 5 +Band n257 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	

Table 6.38.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.38.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_5A_n257A	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, 50, 51, 65, 66, 70, 71, 74	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 26	859	-	869	-27	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	1, 2
	E-UTRA Band 41	F_{DL_low}	-	F_{DL_high}	-50	1	3
	E-UTRA Band 18, 19	F_{DL_low}	-	F_{DL_high}	-40	1	2
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	2

NOTE 1: Applicable when co-existence with PHS system operating in 1884.5 -1915.7MHz
NOTE 2: Applicable only when the assigned E-UTRA carrier is confined within 824 MHz and 849 MHz for UE category M1, M2 and UE category NB1 and NB2.
NOTE 3: 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.

6.38.4 ΔT_{IB} and ΔR_{IB} values

For DC_5A-n257A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.38.4-2: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_5A_n257A	5	0
	n257	0

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Table 6.38.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_5A_n257A	5	0
	n257	0

6.38.5 MSD

From the coexistence analysis Table 6.38.1-1, there was no harmonic/IMD problem into own Rx of bands for DC_5A_n257A UE.

6.39 DC_7A-n78

6.39.1 Operating bands for DC

Table 6.39.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_7A-n78A	7	2500 MHz – 2570 MHz	2620 MHz – 2690 MHz	FDD
	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD

6.39.2 Channel bandwidths per operating band for DC

Table 6.39.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_7A-n78A	7	15		Yes	Yes	Yes						120
	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	

6.39.3 Co-existence studies

Table 6.39.3-1 lists Band 7 +Band n78 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.39.3-1: Band X and Band nY UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	2500	2570	3300	3800
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	5000	5140	6600	7600
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high

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3rd harmonics frequency limits (MHz)	7500	7710	9900	11400
Two tone 2nd 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 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)	1200	1840	4030	5100
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)	8300	8940	9100	10170
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)	3700	4410	7330	8900
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)	10800	11510	12400	13970
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)	2600	1460	11600	12740
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)	12700	10630	6980	6200
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)	15700	17770	13300	14080
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)	6400	4760	1110	100
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)	14900	16540	14100	15310

Based on Table 6.39.3-1;

- There was no harmonic issues at legacy E-UTRA bands and NR new band 3.3~3.8 GHz
- 2nd order IMD may also fall into B5, B8, B12, B13, B14, B17, B18, B19, B20, B26, B27, B28, B67, B68 and TDD B44, B46 and B47.
- 3rd order IMD may also fall into B3, B11, B21, B24, B32 and TDD B45, n77
- 4th order IMD may also fall into B1, B2, B3, B4, B9, B10, B11, B21, B23, B24, B25, B30, B32, B65, B66, TDD B33, B34, B35, B36, B37, B38, B39, B40, B41, B43, B45, n77, n78, n79

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- 5th order IMD may also fall into B5, B8, B12, B13, B14, B17, B18, B19, B20, B26, B27, B28, B29, B31, B67, B68, TDD B44, B46, B47 and n79.

The 4th IMD will be impact to the own received band n78. However, the NR TDD band is not any impacts from dual uplink transmission since there was no simultaneous Tx/Rx transmission in the n78 NR band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.39.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.39.3-2: 2UL Band X +Band nY harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		3rd IMD
Galileo	1559	-	1591	Yes		3rd IMD
GLONASS	1591	-	1610	Yes		3rd IMD
GPS	1563	-	1587	Yes		3rd IMD
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	4th IMD
	2400	-	2494	Yes	Asia	4th IMD
ISM band (5GHz)	5150	-	5925	Yes	US	2nd & 5th IMD
	5150	-	5350	Yes	Europe	5th IMD
	5470	-	5725	Yes		5th IMD
	5150	-	5825	Yes	Asia	2nd & 5th IMD

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Table 6.39.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.39.3-3: Protected bands for the dual connectivity configuration E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_7A-n78A	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	1,2,3
	Frequency range	2575	-	2595	-15.5	5	1,2,3
	Frequency range	2595	-	2620	-40	1	1,2
	Frequency range	3800	-	3805	+1.6	5	1,3,4
	Frequency range	3805	-	3825	-15.5	5	1,3,4
	Frequency range	3825	-	3850	-40	1	1,4
	Frequency range	3850	-	4200	-50	1	

NOTE 1: 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 2: 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 3: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.
NOTE 4: This requirement is applicable for any channel bandwidths within the range 3300 - 3800 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range [TBD – 3792.5] MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range [TBD - 3790] MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to [TBD] RB.

6.39.4 ΔT_{IB} and ΔR_{IB} values

For DC_7A-n78A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are defined to reuse them of the legacy LTE CA_7A-42A UE as given in the tables below.

Table 6.39.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_7A-n78A	7	0.5
	n78	0.8

Table 6.39.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_7A-n78A	7	0
	n78	0.5

6.39.5 MSD

From the coexistence analysis Table 6.39.3-1, there was no harmonic/IMD problems into the own RX frequency bands for DC_7A-n78A UE.

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6.40 DC_7A_n258A

6.40.1 Operating bands for DC

Table 6.40.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_7A_n258A	7	2500 MHz – 2570 MHz	2620 MHz – 2690 MHz	FDD
	n258	24.25 GHz – 27.5 GHz	24.25 GHz – 27.5 GHz	TDD

6.40.2 Channel bandwidths per operating band for DC

Table 6.40.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and 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]
DC_7A_n258A	7	15	Yes	Yes	Yes	Yes								420
	n258	60						Yes			Yes	Yes		
		120						[Yes]			Yes	Yes	Yes	

6.40.3 Co-existence studies

Table 6.40.3-1 lists Band 7 +Band n258 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.40.3-1: Band 7 and Band n258 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	2500	2570	24250	27500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	5000	5140	48500	55000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	7500	7710	72750	82500
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	21680	25000	26750	30070
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)	22500	19110	45930	52500
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)	29250	32640	51000	57570
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)	2100	2970	24230	27520
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)	20000	16540	70180	80000
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	50000	43360		
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)	31750	35210	75250	85070
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	53500	60140		
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)	107500	94430	13970	17500
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)	77500	67610	40790	47500
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)	99500	112570	34250	37780
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)	77750	87640	56000	62710

Based on Table 6.40.3-1;

- 3rd order IMD may fall into Rx frequencies of bands 1, 4, 7, 10, 23, 30, 38, 40, 41, 65, 66, 69 and n257.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.40.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.40.3-2: 2UL Band 7 +Band n258 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD3
	2400	-	2494	Yes	Asia	IMD3
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	

Table 6.40.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.40.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_7A-n258A	E-UTRA Band 1, 3, 5, 7, 8, 26, 28, 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	

6.40.4 ΔT_{IB} and ΔR_{IB} values

For DC_7A_n258A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.40.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_7A_n258A	7	0
	n258	0

Table 6.40.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_7A_n258A	7	0
	n258	0

6.40.5 MSD

There is no MSD issue for this DC configuration

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6.41 DC_8A-n78A

6.41.1 Operating bands for DC

Table 6.41.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_8A-n78A	8	880 MHz – 915 MHz	925 MHz – 960 MHz	FDD
	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD

6.41.2 Channel bandwidths per operating band for DC

Table 6.41.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_8A-n78A	8	15	Yes	Yes								110
	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	

6.41.3 Co-existence studies

Table 6.41.3-1 lists Band 8 +Band n78 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.41.3-1: Band 8 and Band n78 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	880	915	3300	3800
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1760	1830	6600	7600
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2640	2745	9900	11400
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	2385	2920	4180	4715
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)	2040	1470	5685	6720
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)	5060	5630	7480	8515
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)	780	1015	3290	3810
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)	1160	555	8985	10520
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	5840	4770		
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)	5940	6545	10780	12315
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	8360	9430		
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)	14320	12285	360	280
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)	9640	8070	3855	4960
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)	14080	16115	6820	7460
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)	11660	13230	9240	10345

Based on Table 6.41.3-1;

- 2nd order harmonic may fall into Rx frequencies of bands 3
- 3rd order harmonic may fall into Rx frequencies of bands 7, 41
- 2nd order IMD may also fall into Rx frequencies of band 7, 40, 41, 69, n79
- 3rd order IMD may also fall into own Rx of band 8 and Rx frequencies of bands 2, 3, 5, 6, 9, 11, 18, 19, 20, 21, 22, 24, 25, 26, 27, 28, 32, 33, 34, 35, 36, 37, 39, 42, 43, 44, 46, 47, 48, 68, 70,and n77
- 4th order IMD may also fall into own Rx of band 8 and Rx frequencies of bands 5, 6, 12, 13, 14, 17, 18, 19, 20, 26, 27, 28, 29, 44, 46, 67, 68 and n79
- 5th order IMD may also fall into Rx frequencies of bands n77 and n79

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.41.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.41.3-2: 2UL Band 8 +Band n78 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD3
Galileo	1559	-	1591	Yes		IMD3
GLONASS	1591	-	1610	Yes		IMD3
GPS	1563	-	1587	Yes		IMD3
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD2
	2400	-	2494	Yes	Asia	IMD2
ISM band (5GHz)	5150	-	5925	Yes	US	IMD3, 4
	5150	-	5350	Yes	Europe	IMD3, 4
	5470	-	5725	Yes		IMD3, 4
	5150	-	5825	Yes	Asia	IMD3, 4

Table 6.41.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.41.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_8A-n78A	E-UTRA Band 1,8, 20, 28, 34, 39, 40,65	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 3, 7,41	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
	NR Band n257	26500	-	29500	[-5]	100	
	NR Band n258	24250	-	27500	[-5]	100	

6.41.4 ΔT_{IB} and ΔR_{IB} values

For DC_8A-n78A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.41.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_8A-n78A	8	0.6
	n78	0.8
NOTE 1: HTF is assumed for Band 8.		

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Table 6.41.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_8A-n78A	8	0.2
	n78	0.2
NOTE 1: HTF is assumed for Band 8.		

6.41.5 MSD

Table 6.41.5-1 lists the MSD required for the 4th harmonic issue for this DC combination.

Table 6.41.5-1:MSD due to 4th harmonic issue

MSD due to harmonic exception for the DL band										
UL band	**DL band**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**40 MHz**	**50 MHz**	**60 MHZ**	**80 MHZ**	**100 MHZ**
		dB	**dB**	**dB**	**dB**	**dB**	**dB**	**dB**	**dB**	**dB**
8	n78	NA	10.8	9.1	8.0	5.1	4.2	3.5	2.3	1.4
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 4th 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 $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.4 \rfloor 0.1$ in MHz and $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$ 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 6.41.5-2 lists the UL configuration for the EN-DC configuration DC_8A-n78A.

Table 6.41.5-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for low 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	100 MHz
8	n78		16	25	25			25	25	25	25	25

Although Table 6.41.3-1 shows that 3rd and 4th order IMD may fall into own Rx of Band 8,only impact from 4th order IMD shall be considered. because according to R4-1711846, MSD caused by IM3 of "$F_{LTE\ UL}$ - max NR BW" should not be specified due to lower PSD of NR transmission.

Table 6.41.5-3 lists the MSD required for the dual connectivity configuration.

Table 6.41.5-3: MSD due to IMD 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**	
DC_8A-n78A	8	897.5	5	25	942.5	8.3	FDD	IMD4
	n78	3635	10	52	3635	N/A	TDD	N/A

6.41.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.41.3 co-existence studies

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except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.41.6-1.

Table 6.41.6-1: Band 8 and Band n78 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_8A_n78A	8	a	-3	b	-1	4	8	IMD
	n78	c	1	d	0			
DC_8A_n78A	8	a	4	b	0	4	n78	Harmonic
	n78	c	0	d	-1			

Equations (6.41.6.1) and (6.41.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.41.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.41.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.41.6.2)$$

Formula (6.41.6.3-1) and (6.41.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.41.6.3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.41.6.3\text{-}2)$$

6.42 DC_8A-n79A

6.42.1 Operating bands for DC

Table 6.42.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_8A-n79A	8	880 MHz – 915 MHz	925 MHz – 960 MHz	FDD
	n79	4400 MHz – 5000 MHz	4400 MHz – 5000MHz	TDD

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6.42.2 Channel bandwidths per operating band for DC

Table 6.42.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	**E-UTRA and NR 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]**
DC_8A-n79A	8	15	Yes	Yes								110
	n79	15					Yes	Yes				
		30					Yes	Yes	Yes	Yes	Yes	
		60					Yes	Yes	Yes	Yes	Yes	

6.42.3 Co-existence studies

Table 6.42.3-1 lists Band 8 +Band n79 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.42.3-1: Band 8 and Band n79 UL harmonics and IMD products

UE UL carriers	**fx_low**	**fx_high**	**fy_low**	**fy_high**
UL frequency	**880**	**915**	**4400**	**5000**
2nd order harmonics frequency range (MHz)	1760	1830	8800	10000
3rd order harmonics frequency range (MHz)	2640	2745	13200	15000
2nd 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 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)	3240	2570	7885	9120
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)	6160	6830	9680	10915
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)	780	1015	4390	5010
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)	8240	6970	10560	11830
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	|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|

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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

Based on Table 6.42.3-1;

- 2nd order harmonic may fall into Rx frequencies of bands 3
- 3rd order harmonic may fall into Rx frequencies of bands 7 and 41
- 2nd order IMD may also fall into Rx frequencies of band 22, 42, 43, 46, 47, n77 and n78
- 3rd order IMD may also fall into Rx frequencies of bands 5~8, 18~20, 26~28, 38, 41, 68, 69 and n79. However, TDD band does not transmit and receive simultaneously in a single band, thus the own band of n79 would not be interfered
- 4th order IMD may also fall into Rx frequencies of bands 1~4, 9, 10, 23, 25, 30, 33~37, 39, 40, 65, 66 and 70
- 5th order IMD may also fall into Rx frequencies of bands 5, 6, 8, 11~14, 17~20, 26~28, 32, 44, 45, 67 and 68

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.42.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.42.3-2: 2UL Band 8 +Band n79 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	Yes	US	IMD2
	5150	-	5350	Yes	Europe	IMD2
	5470	-	5725	Yes		IMD2
	5150	-	5825	Yes	Asia	IMD2

Table 6.42.3-3 lists the protected bands required for the dual connectivity configuration.

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Table 6.42.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_8A-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
NR	NR Band n257	26500	-	29500	[-5]	100	
	NR Band n258	24250	-	27500	[-5]	100	

6.42.4 ΔT_{IB} and ΔR_{IB} values

For DC_8A-n79A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.42.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_8A-n79A	8	0
	n79	0

Table 6.42.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_8A-n79A	8	0
	n79	0

6.42.5 MSD

Table 6.42.5-1 lists the MSD required for the 5th harmonic issue for this DC combination.

Table 6.42.5-1:MSD due to 5th harmonic issue

UL band	DL band	[40] MHz	50 MHz	[60] MHZ	80 MHZ	100 MHZ
		dB	dB	dB	dB	dB
8	n79	[6.8]	6.2	[5.6]	4.9	4.4
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 EARFCN of a low band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.5 \rfloor 0.1$ in MHz and $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$ 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.						

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Table 6.42.5-2 lists the UL configuration for the EN-DC configuration DC_8A-n79A.

Table 6.42.5-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for EN-DC in NR FR1

UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz
8	n79							25	25	25	25	25

Although Table 6.42.3-1 shows that 3rd and 5th order IMD may fall into own Rx of Band 8, only impact from 5th order IMD shall be considered and the MSD caused by IM3 of "$F_{LTE\ UL}$ - max NR BW" should not be specified due to lower PSD of NR transmission.

Table 6.42.5-3 lists the MSD required for the dual connectivity configuration.

Table 6.42.5-3: MSD due to IMD 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	
DC_8A-n79A	8	897.5	5	25	942.5	4.8	FDD	IMD5
	n79	4532.5	40	216	4532.5	N/A	TDD	N/A

6.42.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.42.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.42.6-1.

Table 6.42.6-1: Band 8 and Band n79 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_8A_n79A	8	a	-4	b	-1	5	8	IMD
	n79	c	1	d	0			
DC_8A_n79A	8	a	5	b	0	5	n79	Harmonic
	n79	c	0	d	-1			
DC_8A_n79A	8	a	0	b	-5	5	8	Harmonic mixing
	n79	c	1	d	0			

Equations (6.42.6.1) and (6.42.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.42.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.42.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.42.6.2)$$

Formula (6.42.6.3-1) and (6.42.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.42.6.3\text{-}1)$$

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$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX\,2}}{2} \quad (6.42.6.3\text{-}2)$$

6.43 DC_8A-n258A

6.43.1 Operating bands for DC

Table 6.43.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_8A-n258A	8	880 MHz – 915 MHz	925 MHz – 960 MHz	FDD
	n258	24250 MHz – 27500 MHz	24250 MHz – 27500 MHz	TDD

6.43.2 Channel bandwidths per operating band for DC

Table 6.43.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	50 MHz	100 MHz	[200 MHz]	400 MHz	Maximum aggregated bandwidth [MHz]
DC_8A-n258A	8	15	Yes	Yes							410
	n258	60					Yes	Yes	Yes		
		120					Yes	Yes	Yes	Yes	

6.43.3 Co-existence studies

Table 6.43.3-1 lists Band 8 +Band n258 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.43.3-1: Band 8 and Band n258 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency	**880**	**915**	**24250**	**27500**
2nd order harmonics frequency range (MHz)	1760	1830	48500	55000
3rd order harmonics frequency range (MHz)	2640	2745	72750	82500
2nd order IMD products	|fy_low-fx_high|	|fy_high-fx_low|	|fy_low+fx_low|	|fy_high+fx_high|
IMD frequency limits (MHz)	23335	26620	25130	28415
Two-tone 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)	25740	22420	47585	54120
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)	26010	29330	49380	55915
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)

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IMD frequency limits (MHz)	480	1315	24240	27510
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)	53240	46670	50260	56830
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)	24860	21505	71835	81620
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)	26890	30245	73630	83380
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)	109120	96085	20590	23980
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)	97880	110915	27770	31160
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)	80740	70920	45755	52360
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)	74510	84330	51140	57745

Based on Table 6.43.3-1;

- 2nd order harmonic may fall into Rx frequencies of bands 3
- 3rd order harmonic may fall into Rx frequencies of bands 7 and 41.
- 2nd order and 4th IMD may also fall into own Rx of band n258 and Rx frequencies of band n257. However, TDD band does not transmit and receive simultaneously in a single band, thus the own band of n258 would not be interfered.
- 3rd order IMD may also fall into own Rx of band 8 and n258 and Rx frequencies of bands 5, 6, 12~14, 17~20, 26~29, 44, 67, 68 and n257.
- 5th order IMD may also fall into Rx frequencies of bands n257.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.43.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.43.3-2: 2UL Band 8 +Band n258 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	

Table 6.43.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.43.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_8A-n258A	E-UTRA Band 1,8, 20, 28, 34, 39, 40,65	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 3, 7,41,42,n78,n79	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

6.43.4 ΔT_{IB} and ΔR_{IB} values

For DC_8A-n258A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.43.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_8A-n258A	8	0
	n258	0

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Table 6.43.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_8A-n258A	8	0
	n258	0

6.43.5 MSD

There is no IMD issue for own Rx range in this combination taking actual spectrum holding into account and the MSD requirement is shown in table 6.43.5-1.

Table 6.43.5-1: MSD for DC configuration

E-UTRA Band / Channel bandwidth / N_{RB} / Duplex mode							
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-n258	8	N/A	N/A	N/A	N/A	N/A	FDD
	n258	N/A	N/A	N/A	N/A	N/A	TDD

6.44 DC_19A-n257

6.44.1 Operating bands for DC

Table 6.44.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_19A_n257	19	830 MHz – 845 MHz	875 MHz – 890 MHz	FDD
	n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD

6.44.2 Channel bandwidths per operating band for DC

Table 6.44.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	[50 MHz]	100 MHz	200 MHz	400 MHz	Maximum aggregated bandwidth [MHz]
DC_19A_n257A	19	15	Yes	Yes	Yes						415
	n257	60					Yes	Yes	Yes		
		120					Yes	Yes	Yes	Yes	
DC_19A_n257D	19	15	Yes	Yes	Yes						415
	n257	See CA_n257D in Table 5.5A1-2 in TS 38.101-2 [4]									
DC_19A_n257E	19	15	Yes	Yes	Yes						615
	n257	See CA_n257E in Table 5.5A1-2 in TS 38.101-2 [4]									
DC_19A_n257F	19	15	Yes	Yes	Yes						815
	n257	See CA_n257F in Table 5.5A1-2 in TS 38.101-2 [4]									

6.44.3 Co-existence studies

Table 6.44.3-1 lists Band 19 +Band n257 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.44.3-1: Band 19 and Band n257 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	830	845	26500	29500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1660	1690	53000	59000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2490	2535	79500	88500
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	25655	28670	27330	30345
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)	24810	27840	52155	58170
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)	28160	31190	53830	59845
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)	430	1245	26485	29515
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)	23965	27010	78655	87670
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	51310	57340		
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)	28990	32035	80330	89345
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	54660	60690		
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)	105155	117170	23120	26180
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)	77810	86840	50465	56510
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)	106830	118845	29820	32880
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)	81160	90190	55490	61535

Based on Table 6.44.3-1;

- 3rd order harmonic may fall into Rx frequencies of bands 41
- 2nd order IMD may also fall into Rx frequencies of bands n257 and n258
- 3rd order IMD may also fall into Rx frequencies of bands 5, 6, 8, 12, 13, 14, 17, 18, 19, 20, 26, 27, 28, 29, 31, 44, 67, 68, n257 and n258
- 4th order IMD may also fall into Rx frequencies of bands n257 and n258
- 5th order IMD may also fall into Rx frequencies of bands n258

When 2UL inter-band DC UE is operating with other systems such as Wi-Fi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.44.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.44.3-2: 2UL Band 19 +Band n257 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	Yes	Asia	Harmonic3
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	Yes	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	

Table 6.44.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.44.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_19A-n257A	E-UTRA Band 1, 3, 11, 21, 28, 34, 42, 65, n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	

6.44.4 ΔT_{IB} and ΔR_{IB} values

For DC_19A_n257, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.44.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_19A_n257	19	0
	n257	0

Table 6.44.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_19A_n257	19	0
	n257	0

6.44.5 MSD

No IMD issues are expected for DC configuration between the LTE bands below 6GHz and FR2 NR band. Furthermore, up to 7th order harmonics have no impact to Rx frequency of both LTE and NR bands.

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6.45 DC_20A-n78A

6.45.1 Operating bands for DC

Table 6.45.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_20A-n78A	20	832 MHz – 862 MHz	791 MHz – 821 MHz	FDD
	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD

6.45.2 Channel bandwidths per operating band for DC

Table 6.45.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_20A-n78A	20	15	Yes	Yes	Yes	Yes						120
	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	

6.45.3 Co-existence studies

For 2UL/2DL UE coexistence study 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order intermodulation products were calculated and presented in Table 6.45.3-1

Table 6.45.3-1: Harmonic and IMD analysis

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	832	862	3300	3800
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1664	1724	6600	7600
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2496	2586	9900	11400
Two tone 2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	2438	2968	4132	4662
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)	2136	1576	5738	6768
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|

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IMD frequency limits (MHz)	4964	5524	7432	8462
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)	1304	714	9038	10568
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)	5796	6386	10732	12262
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)	5936	4876	8264	9324
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)	14368	12338	148	472
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)	14032	16062	6628	7248
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)	9736	8176	4014	5104
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)	11564	13124	9096	10186

Based on the table 6.45.3-1, the 4 order IMD products may fall in the own Rx of Band 20. In addition, 3rd order harmonic and 2nd, 3rd, 4th and 5th IMD products may also fall into Rx frequencies of bands 1-10, 12-14, 17-20, 25-29, 31, 33-39, 41, 44, 46-70 and n77.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.45.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.45.3-2: 2UL Band x +Band y harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD 3
Galileo	1559	-	1591	Yes		IMD 3
GLONASS	1591	-	1610	Yes		IMD 3
GPS	1563	-	1587	Yes		IMD 3
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD 2
	2400	-	2494	Yes	Asia	IMD 2
ISM band (5GHz)	5150	-	5925	Yes	US	IMD3, 4
	5150	-	5350	Yes	Europe	IMD3, 4
	5470	-	5725	Yes		IMD3, 4
	5150	-	5825	Yes	Asia	IMD3, 4

Table 6.45.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.45.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_20A-n78A	E-UTRA Band 1, 3, 7, 8, 31, 32, 33, 34, 40, 50, 51, 65, 67, 68, 72, 74, 75, 76						
	E-UTRA Band 20	F_{DL_low}	-	F_{DL_high}	-50	1	15
	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 6.6.3.1-2 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 15: 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.							

6.45.4 ΔT_{IB} and ΔR_{IB} values

For DC_20A-n78A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.41.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_20A-n78A	20	0.6
	n78	0.8

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Table 6.41.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_20A-n78A	20	0
	n78	0.5

6.45.5 MSD

Table 6.45.5-1 lists the MSD required for the dual connectivity configuration.

Table 6.45.5-1: MSD due to IMD issue for DC_20-n78A

E-UTRA Band / Channel bandwidth / N_{RB} / Duplex mode								Source of IMD
EUTRA/NR DC Configuration	EUTRA/NR band	UL F_c (MHz)	UL/DL BW (MHz)	UL C_{LRB}	DL F_c (MHz)	MSD (dB)	Duplex mode	
DC_20A-n78A	20	850	5	25	810	21.7	FDD	IMD4[4]
	n78	3360	10	50	3360	N/A	TDD	N/A

The MSD level for Band n78 by 4th harmonic from Band 20 can reuse the value from LTE CA_20A-42A. Table 6.45.5-2 shows the MSD level for DC_20A-n78A. The MSD for 40MHz was calculated based on 20MHz, since the interference are same.

Table 6.45.5-2: MSD due to harmonic issue for DC_20-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
20	n78[1,2]		10.8	9.1	8		6				
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 4th 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 $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.4 \rfloor 0.1$ in MHz and $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$ 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.											

Regarding the uplink configuration, 40MHz for n78 should be considered additionally. Therefore, 20MHz with 100RB allocation for Band 20 should be added.

Table 6.45.5-3: Uplink configuration for the low band (exceptions) for E-UTRA

E-UTRA Band / Channel bandwidth of the high band / N_{RB} / Duplex mode									
LTE-NR DC band combination	UL band	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz	20 MHz	Duplex mode
DC_20A-n78A	20			8	16	25	25[1]	25[2]	FDD
NOTE 1: The configuration is used for measurement of MSD for NR channel bandwidth of 20MHz. NOTE 2: The configuration is used for measurement of MSD for NR channel bandwidth of 40MHz.									

6.45.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.45.3 co-existence studies

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except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.45.6-1.

Table 6.45.6-1: Band 20 and Band n78 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_20A_n78A	20	a	-3	b	-1	4	20	IMD
	n78	c	1	d	0			
DC_20A_n78A	20	a	4	b	0	4	n78	Harmonic
	n78	c	0	d	-1			

Equations (6.45.6.1) and (6.45.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.45.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.45.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.45.6.2)$$

Formula (6.45.6.3-1) and (6.45.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.45.6.3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.45.6.3\text{-}2)$$

6.46 DC_21A-n257

6.46.1 Operating bands for DC

Table 6.46.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band BS receive / UE transmit $F_{UL\_low} – F_{UL\_high}$	Downlink (DL) band BS transmit / UE receive $F_{DL\_low} – F_{DL\_high}$	Duplex mode
DC_21A_n257	21	1447.9 MHz – 1462.9 MHz	1495.9 MHz – 1510.9 MHz	FDD
	n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD

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6.46.2 Channel bandwidths per operating band for DC

Table 6.46.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	[50 MHz]	100 MHz	200 MHz	400 MHz	Maximum aggregated bandwidth [MHz]
DC_21A_n257A	21	15	Yes	Yes	Yes						415
	n257	60					Yes	Yes	Yes		
		120					Yes	Yes	Yes	Yes	
DC_21A_n257D	21	15	Yes	Yes	Yes						415
	n257	See CA_n257D in Table 5.5A1-2 in TS 38.101-2 [4]									
DC_21A_n257E	21	15	Yes	Yes	Yes						615
	n257	See CA_n257E in Table 5.5A1-2 in TS 38.101-2 [4]									
DC_21A_n257F	21	15	Yes	Yes	Yes						815
	n257	See CA_n257F in Table 5.5A1-2 in TS 38.101-2 [4]									

6.46.3 Co-existence studies

Table 6.46.3-1 lists Band 21 +Band n257 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.46.3-1: Band 21 and Band n257 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1447.9	1462.9	26500	29500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	2895.8	2925.8	53000	59000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	4343.7	4388.7	79500	88500
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	25037.1	28052.1	27947.9	30962.9
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)	23574.2	26604.2	51537.1	57552.1
Two-tone 3rd order IMD products	(2*f1_low + f2_low)	(2*f1_high + f2_high)	(2*f2_low + f1_low)	(2*f2_high + f1_high)
IMD frequency limits (MHz)	29395.8	32425.8	54447.9	60462.9
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)	1047.9	1862.9	26485	29515
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)	22111.3	25156.3	78037.1	87052.1
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	50074.2	56104.2		
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)	30843.7	33888.7	80947.9	89962.9
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	55895.8	61925.8		
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)	104537.1	116552.1	20648.4	23708.4
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)	76574.2	85604.2	48611.3	54656.3
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)	107447.9	119462.9	32291.6	35351.6
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)	82395.8	91425.8	57343.7	63388.7

Based on Table 6.46.3-1;

- 2nd order IMD may also fall into Rx frequencies of bands n257 and n258
- 3rd order IMD may also fall into Rx frequencies of bands 3, 9, 11, 21, 24, 35, 45, n257 and n258
- 4th order IMD may also fall into Rx frequencies of bands n258

When 2UL inter-band DC UE is operating with other systems such as Wi-Fi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.46.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.46.3-2: 2UL Band 21 +Band n257 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD3
Galileo	1559	-	1591	Yes		IMD3
GLONASS	1591	-	1610	Yes		IMD3
GPS	1563	-	1587	Yes		IMD3
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	

Table 6.46.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.46.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_21A-n257A	E-UTRA Band 1, 3, 18, 19, 21, 28, 34, 42, 65, n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	

6.46.4 ΔT_{IB} and ΔR_{IB} values

For DC_21A_n257, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.46.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_21A_n257	21	0
	n257	0

Table 6.46.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_21A_n257	21	0
	n257	0

6.46.5 MSD

No IMD issues are expected for DC configuration between the LTE bands below 6GHz and FR2 NR band. Furthermore, up to 7th order harmonics have no impact to Rx frequency of both LTE and NR bands.

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6.47 DC_28A-n257

6.47.1 Operating bands for DC

Table 6.47.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_28A_n257	28	703 MHz – 748 MHz	758 MHz – 803 MHz	FDD
	n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD

6.47.2 Channel bandwidths per operating band for DC

Table 6.47.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	[50 MHz]	100 MHz	200 MHz	400 MHz	Maximum aggregated bandwidth [MHz]
DC_28A_n257A	28	15	Yes	Yes							410
	n257	60					Yes	Yes	Yes		
		120					Yes	Yes	Yes	Yes	
DC_28A_n257D	28	15	Yes	Yes							410
	n257	See CA_n257D in Table 5.5A1-2 in TS 38.101-2 [4]									
DC_28A_n257E	28	15	Yes	Yes							610
	n257	See CA_n257E in Table 5.5A1-2 in TS 38.101-2 [4]									
DC_28A_n257F	28	15	Yes	Yes							810
	n257	See CA_n257F in Table 5.5A1-2 in TS 38.101-2 [4]									

6.47.3 Co-existence studies

Table 6.47.3-1 lists Band 28 +Band n257 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.47.3-1: Band 28 and Band n257 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	703	748	26500	29500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1406	1496	53000	59000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2109	2244	79500	88500
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)	25004	28094	52252	58297
Two-tone 3rd order IMD products	(2*f1_low + f2_low)	(2*f1_high + f2_high)	(2*f2_low + f1_low)	(2*f2_high + f1_high)
IMD frequency limits (MHz)	27906	30996	53703	59748
Two-tone 3rd order IMD products	(f1_low – max BW f2)	(f1_high + max BW f2)	(f2_low – max BW f1)	(f2_high + max BW f1)
IMD frequency limits (MHz)	303	1148	26490	29510
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)	24256	27391	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)	105252	117297	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)	78004	87094	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 6.47.3-1;

- 2nd order harmonic may fall into Rx frequency of band 11, 21 and 45
- 3rd order harmonic may fall into Rx frequencies of bands 1, 4, 10, 23, 65 and 66
- 2nd order IMD may also fall into Rx frequencies of bands n257 and n258
- 3rd order IMD may also fall into Rx frequencies of bands 5, 6, 8, 12, 13, 14, 17, 18, 19, 20, 26, 27, 28, 29, 31, 44, 67, 68, n257 and n258
- 4th order IMD may also fall into Rx frequencies of bands n257 and n258
- 5th order IMD may also fall into Rx frequencies of bands n257 and n258

When 2UL inter-band DC UE is operating with other systems such as Wi-Fi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.47.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.47.3-2: 2UL Band 28 +Band n257 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	

Table 6.47.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.47.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_28A-n257A	E-UTRA Band 3, 5, 8, 18, 19, 34, 39, 40, 41	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 1, 65	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception
	E-UTRA Band 1	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception of -36 dBm/MHz for 718-748 MHz
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception of -38 dBm/MHz for 718-748 MHz
	Frequency range	758	-	773	-32	1	
	Frequency range	773	-	803	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS

6.47.4 ΔT_{IB} and ΔR_{IB} values

For DC_28A_n257, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.47.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_28A_n257	28	0
	n257	0

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Table 6.47.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_28A_n257	28	0
	n257	0

6.47.5 MSD

No IMD issues are expected for DC configuration between the LTE bands below 6GHz and FR2 NR band. Furthermore, up to 7th order harmonics have no impact to Rx frequency of both LTE and NR bands.

6.48 DC_28A_n258A

6.48.1 Operating bands for DC

Table 6.48.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_28A_n258A	28	703 MHz – 748 MHz	758 MHz – 803 MHz	FDD
	n258	24.25 GHz – 27.5 GHz	24.25 GHz – 27.5 GHz	TDD

6.48.2 Channel bandwidths per operating band for DC

Table 6.48.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and 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]
DC_28A_n258A	28	15	Yes	Yes	Yes	Yes								420
	n258	60						Yes			Yes	Yes		
		120						[Yes]			Yes	Yes	Yes	

6.48.3 Co-existence studies

Table 6.48.3-1 lists Band 28 +Band n258 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.48.3-1: Band 28 and Band n258 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	703	748	24250	27500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1406	1496	48500	55000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2109	2244	72750	82500
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	23502	26797	24953	28248
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)	26094	22754	47752	54297
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)	25656	28996	49203	55748
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)	303	1148	24230	27520
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)	25391	22006	72002	81797
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	53594	47004		
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)	26359	29744	73453	83248
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	49906	56496		
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)	109297	96252	21258	24688
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)	81094	71254	46256	52891
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)	97703	110748	27062	30492
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)	74156	83996	50609	57244

Based on Table 6.48.3-1;

- 3rd order IMD may fall into own Rx of Band n258 and Rx frequencies of bands 5, 8, 12, 13, 14, 17, 18, 19, 20, 26, 27, 28, 29, 31, 44, 67, 68 and n257.
- 4th order IMD may fall into own Rx of Band n258 and Rx frequencies of band n257.
- 5th order IMD may fall into own Rx of Band n258 and Rx frequencies of band n257.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.48.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.48.3-2: 2UL Band 28 +Band n258 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	

Table 6.48.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.48.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_28A_n258A	E-UTRA Band 3, 5, 8, 18, 19, 34, 39, 40, 41	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 1, 65	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception
	E-UTRA Band 1	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception of -36 dBm/MHz for 718-748 MHz
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	Harmonic exception of -38 dBm/MHz for 718-748 MHz
	Frequency range	758	-	773	-32	1	
	Frequency range	773	-	803	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	PHS

6.48.4 ΔT_{IB} and ΔR_{IB} values

For DC_28A_n258A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.48.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_28A_n258A	28	0
	n258	0

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Table 6.48.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_28A_n258A	28	0
	n258	0

6.48.5 MSD

There is no MSD issue for this DC configuration

6.49 DC_38A-n78A

6.49.1 Operating bands for DC

Table 6.49.1-1: DC band combination of LTE 2DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band	Downlink (DL) band	Duplex mode
		BS receive / UE transmit	BS transmit / UE receive	
		$F_{UL\_low} – F_{UL\_high}$	$F_{DL\_low} – F_{DL\_high}$	
DC_38A-n78A	38	2570 MHz – 2620 MHz	2570 MHz – 2620 MHz	TDD
	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	

6.49.2 Channel bandwidths per operating band for DC

Table 6.49.2-1: Supported bandwidths per DC band combination of LTE 2DL/1UL + one NR band

	DC operating / channel bandwidth											
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_3A-38A-n78	38	15	Yes	Yes	Yes	Yes						120
	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	

6.49.3 Co-existence studies

Since simultaneous transmission of LTE Band 38 and NR Band n78 are not supported, at least in Rel-15, co-existence studies are not needed.

6.49.4 ΔT_{IB} and ΔR_{IB} values

For DC_38A-n78A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

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Table 6.49.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_38A-n78A	38	0
	n78	0.5

Table 6.49.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_38A-n78A	38	0.4
	n78	0.5

6.49.5 MSD

There is no MSD issue for this DC configuration based on the following conditions:

- LTE Band 38 and NR Band n78 are synchronised
- Simultaneous transmission of LTE Band 38 and NR Band n78 are not supported at least in Rel-15 timeframe

6.50 DC_39A-n79A

6.50.1 Operating bands for DC

Table 6.50.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band	Downlink (DL) band	Duplex mode
		BS receive / UE transmit	BS transmit / UE receive	
		FUL_low – FUL_high	FDL_low – FDL_high	
DC_39A-n79A	39	1880 MHz – 1920 MHz	1880 MHz – 1920 MHz	TDD
	n79	4400 MHz – 5000 MHz	4400 MHz – 5000 MHz	TDD

6.50.2 Channel bandwidths per operating band for DC

Table 6.50.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_39A-n79A	39	15	Yes	Yes	Yes	Yes						120
	n79	15					Yes	Yes				
		30					Yes	Yes	Yes	Yes	Yes	
		60					Yes	Yes	Yes	Yes	Yes	

6.50.3 Co-existence studies

Table 6.50.3-1 lists up to 7th order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 39+Band n79 2UL DC.

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Table 6.50.3-1: Band 39 and Band n79 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1880	1920	4400	5000
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3760-3840		8800-10000	
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5640-5760		13200-15000	
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	7520-7680		17600-20000	
5th harmonics frequency limits	5*fx_low	5*fx_high	5*fy_low	5*fy_high
5th harmonics frequency limits (MHz)	9400-9600		22000-18000	
6th harmonics frequency limits	6*fx_low	6*fx_high	6*fy_low	6*fy_high
6th harmonics frequency limits (MHz)	11280-11520		26400-3000	
7th harmonics frequency limits	7*fx_low	7*fx_high	7*fy_low	7*fy_high
7th harmonics frequency limits (MHz)	13160-13440		30800-35000	
2nd 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 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)	1240-560		6880-8120	
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)	8160-8840		10680-11920	
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)	1780-2020		4380-5020	
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)	640-1360		11280-13120	
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	6240-4960			
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)	10040-10760		15080-16920	
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	12560-13840			
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)	18120-15680		3280-2520	
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)	11240-9360		3040-4360	
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)	19480-21920		11920-12680	
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)	16960-18840		14440-15760	

Based on Table 6.50.3-1, the 3rd 4th order IMD product may also fall into Band 39. However it should be noted that IMD will not be an issue for TDD bands (no self-interference for the TDD band) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.50.3-2 lists if up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.50.3-2: Band 39 and Band n79 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	NO		
Galileo	1559	-	1591	NO		
GLONASS	1591	-	1610	NO		
GPS	1563	-	1587	NO		
ISM band (2.4GHz)	2400	-	2483.5	YES	US/Europe	2nd IMD
	2400	-	2494	YES	Asia	2nd IMD
ISM band (5GHz)	5150	-	5925	Yes	US	3rd Harmonic
	5150	-	5350	NO	Europe	
	5470	-	5725	YES		3rd Harmonic
	5150	-	5825	YES	Asia	3rd harmonic

Table 6.50.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.50.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_39A-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	N
	Frequency range	1855	-	1880	-15.5	5	N
	NR Band n258	FDL_low	-	FDL_high	[-5]	100	
NOTE N: 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.							

6.50.4 ΔTIB and ΔRIB values

For DC_39A-n79A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in Table 6.50.4-1 Table 6.50.4-2 for UEs not supporting simultaneous Tx/Rx.

Table 6.50.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_39A-n79A	39	0.3
	n79	0.8

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Table 6.50.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_39A-n79A	39	0
	n79	0.5

6.50.5 MSD

No IMD issue is identified for this combination.

6.51 DC_41A-n77A

6.51.1 Operating bands for DC

Table 6.51.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_41A-n77A	41	2496 MHz – 2690 MHz	2496 MHz – 2690 MHz	TDD
	n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	TDD

6.51.2 Channel bandwidths per operating band for DC

Table 6.51.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_41A-n77A	41	15	Yes	Yes	Yes	Yes						120
	n77	15		Yes	Yes	Yes	Yes	Yes				
		30		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
		60		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

6.51.3 Co-existence studies

Table 6.51.3-1 lists up to 7th order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 41+Band n77 2UL DC.

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Table 6.51.3-1: Band 41 and Band n77 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	2496	2690	3300	4200
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	4992-5380		6600-8400	
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	7488-8070		9900-12600	
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	9984-10760		13200-16800	
5th harmonics frequency limits	5*fx_low	5*fx_high	5*fy_low	5*fy_high
5th harmonics frequency limits (MHz)	12480-13450		16500-21000	
6th harmonics frequency limits	6*fx_low	6*fx_high	6*fy_low	6*fy_high
	14976-16140		19800-25200	
7th harmonics frequency limits	7*fx_low	7*fx_high	7*fy_low	7*fy_high
7th harmonics frequency limits (MHz)	17472-18830		23100-29400	
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	610-1704		5796-6890	
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)	792-2080		3910-5904	
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)	8292-9580		9096-11090	
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)	2396-2790		3280-4220	
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)	3288-4770		7210-10104	
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	1220-3408			
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)	10788-12270		12396-15290	
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	11592-13780			
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)	10510-14304		5784-7460	
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)	4520-7608		912-1470	
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)	15696-19490		13284-14960	
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)	14892-17980		14088-16470	

Based on Table 6.51.3-1, the 3rd and 4th order IMD may fall into Band 41 and Band n77. However, it should be noted that IMD will not be an issue for TDD bands (no self-interference for the TDD band) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.51.3-2 lists if up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.51.3-2: Band 41 and Band n77 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		2nd, 3rd, 4th IMD
Galileo	1559	-	1591	Yes		2nd, 3rd, 4th IMD
GLONASS	1591	-	1610	Yes		2nd, 3rd, 4th IMD
GPS	1563	-	1587	Yes		2nd, 3rd, 4th IMD
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	3rd, 4th IMD
	2400	-	2494	Yes	Asia	3rd, 4th IMD
ISM band (5GHz)	5150	-	5925	Yes	US	2nd harmonic, 2nd, 3rd IMD
	5150	-	5350	Yes	Europe	2nd harmonic, , 3rd IMD
	5470	-	5725	Yes		3rd IMD
	5150	-	5825	Yes	Asia	2nd harmonic, 2nd, 3rd IMD

Table 6.51.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.51.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_41A-n77A	E-UTRA Band 1, 3, 5, 8, 26, 28, 33, 34, 39, 40, 44, 45, 73, 74	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 9, 11, 18, 19, 21	F_{DL_low}	-	F_{DL_high}	-50	1	30
	Frequency range	1884.5		1915.7	-41	0.3	8, 30
	NR Band n257	26500	-	29500	[-5]	100	
NOTE 8: Applicable when co-existence with PHS system operating in 1884.5 -1915.7MHz. NOTE 30: This requirement applies when the E-UTRA carrier is confined within 2545-2575MHz or 2595-2645MHz and the channel bandwidth is 10 or 20 MHz							

6.51.4 ΔTIB and ΔRIB values

Table 6.51.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_41A-n77A	41	0.3
	n77	0.8

Table 6.51.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_41A-n77A	41	0
	n77	0.5

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6.51.5 MSD

B41 and n77 are both TDD and close in frequency and lack of isolation in the band filters will result in Rx bands noise from the Tx path of one band de-sensing the Rx of the other band. Three scenarios of desensitization are identified for this combination.

Firstly, B41 Rx is also affected due to n77 Tx leakage (4.5dB). This MSD is capatured in Table 6.51.5-1 with uplink configuration shown in Table 6.51.5-2.

Secondly, n77 Rx is affected by B41 Tx wideband noise leakage that causes MSD =8.3 dB when 2x n77 Tx = 3x B41 Rx is satisfied.

Thirdly, 3rd order harmonic mixing at B41 Rx would be caused by the leakage of 2nd harmonics of n77 Tx, which happens when 2x n77 Tx = 3x B41 Rx is satisfied..

Two MSDs for harmonic mixing are captured in Table 6.51.5-3 with uplink configuration in Table 6.51.5-4.

Note that these MSDs only happen when two bands are operated in asynchronous manner.

Table 6.51.5-1: MSD for reference sensitivity exceptions due to cross band isolation for EN-DC.

Channel bandwidth											
EUTRA/NR DC Configuration	**EUTRA/NR band**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**40 MHz**	**50 MHz**	**60 MHz**	**80 MHz**	**100 MHz**	**Duplex mode**
CA_41A-n77A	41[1]	-93.5	-90.5	-88.7	-87.5						TDD
NOTE 1: Applicable only when harmonic mixing MSD for this combination is not applied.											

Table 6.51.5-2: Uplink configuration for reference sensitivity exceptions due to cross band isolation for EN-DC

UL band	DL band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz
n77	41	30	273	273	273	273	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 6.51.5-3: MSD for reference sensitivity exceptions due to receiver harmonic mixing for EN-DC in NR FR1

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)	100 MHz (dB)
41	n77[1]	N/A	8.3	8.0	6.9	N/A	3.9	3	2.3	1.2	0.4
n77	41[2]	10.4	10.4	10.4	10.4	N/A	N/A	N/A	N/A	N/A	N/A

NOTE 1: The requirements should be verified for UL EARFCN of the aggressor (lower) band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.15 \rfloor 0.1$ in MHz and $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$ 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 EARFCN of the aggressor (higher) band (superscript HB) such that $f_{UL}^{LB} = \lfloor 15 * f_{DL}^{HB} \rfloor 0.1$ in MHz and $F_{UL\_low}^{HB} + BW_{Channel}^{HB} / 2 \le f_{UL}^{HB} \le f_{UL\_high}^{HB} - BW_{Channel}^{HB} / 2$ with f_{DL}^{LB} carrier frequency in the victim (lower) band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the higher band.

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Table 6.51.5-4: Uplink configuration for reference sensitivity exceptions due to receiver harmonic mixing for EN-DC in NR FR1

UL band	DL band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz
41	n77	15	25	25	25	25	N/A	N/A	N/A	N/A	N/A	N/A
n77	41	30	N/A	50	50	50	N/A	50	50	50	50	50

6.51.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.51.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.51.6-1.

Table 6.51.6-1: Band 41 and Band n77 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_41A_n77A	41	a	3	b	0	2	n77	Harmonic mixing
	n77	c	0	d	-1			
	41	a	0	b	-2	3	41	Harmonic mixing
	n77	c	2	d	0			

Equations (6.51.6.1) and (6.51.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.51.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.51.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.51.6.2)$$

Formula (6.51.6.3-1) and (6.51.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.51.6.3\text{-}1)$$

$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.51.6.3\text{-}2)$$

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6.52 DC_41A-n78A

6.52.1 Operating bands for DC

Table 6.52.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band	Downlink (DL) band	Duplex mode
		BS receive / UE transmit	BS transmit / UE receive	
		FUL_low – FUL_high	FDL_low – FDL_high	
DC_41A-n78A	41	2496 MHz – 2690 MHz	2496 MHz – 2690 MHz	TDD
	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD

6.52.2 Channel bandwidths per operating band for DC

Table 6.52.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_41A-n78A	41	15	Yes	Yes	Yes	Yes						120
	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	

6.52.3 Co-existence studies

Table 6.52.3-1 lists up to 7th order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 41+Band n78 2UL DC.

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Table 6.52.3-1: Band 41 and Band n78 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	2496	2690	3300	3800
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	4992-5380		6600-7600	
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd 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	
6th harmonics frequency limits	6*fx_low	6*fx_high	6*fy_low	6*fy_high
	14976-16140		19800-22800	
7th harmonics frequency limits	7*fx_low	7*fx_high	7*fy_low	7*fy_high
7th harmonics frequency limits (MHz)	17472-18830		23100-26600	
2nd 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 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)	1192-2080		3910-5104	
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)	8292-9180		9096-10290	
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)	2396-2790		3280-3820	
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)	3688-4770		7210-8904	
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	1220-2680			
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)	10788-11870		12396-14090	
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	11592-12980			
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)	10510-12704		6184-7460	
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)	4520-6408		112-1470	
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)	15696-17890		13248-14560	
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)	14892-16780		14088-15670	

Based on Table 6.52.3-1, the 3rd and 4th order IMD may fall into Band 41 and Band n78. However, it should be noted that IMD will not be an issue for TDD bands (no self-interference for the TDD band) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.52.3-2 lists if up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.52.3-2: Band 41 and Band n78 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		3rd, 4th IMD
Galileo	1559	-	1591	Yes		3rd, 4th IMD
GLONASS	1591	-	1610	Yes		3rd, 4th IMD
GPS	1563	-	1587	Yes		3rd, 4th IMD
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	3rd, 4th IMD
	2400	-	2494	Yes	Asia	3rd, 4th IMD
ISM band (5GHz)	5150	-	5925	Yes	US	2nd harmonic, 2nd, 5th IMD
	5150	-	5350	Yes	Europe	2nd harmonic, 5th IMD
	5470	-	5725	Yes		5th IMD
	5150	-	5825	Yes	Asia	2nd harmonic, 2nd, 5th IMD

Table 6.52.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.52.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_41A-n78A	E-UTRA Band 1, 3, 8, 34, 39, 40, 44, 45 or NR Band n1, n8, n34, n40, n79	FDL_low	-	FDL_high	-50	1	
	Frequency range	FDL_low	-	FDL_high	[-5]	100	

6.52.4 ΔTIB and ΔRIB values

For DC_41A-n78A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in Table 6.52.4-1 Table 6.52.4-2.

Table 6.52.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_41A-n78A	41	0.3
	n78	0.8

Table 6.52.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_41A-n78A	41	0
	n78	0.5

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6.52.5 MSD

Band 41 and n78 are both TDD bands and are close in frequency. For unsynchronized operation, Rx de-sensing in one band will be caused by another band due to lack of isolation in the band filters. Three scenarios of desensitization are identified for this combination as below.

- Firstly, B41 Rx is also affected due to n78 Tx leakage (4.5dB). This MSD is capatured in Table 6.52.5-1 with uplink configuration shown in Table 6.52.5-2..
- Secondly, n78 Rx is affected by B41 Tx wideband noise leakage that causes MSD =8.3 dB when 2x n78 Tx = 3x B41 Rx is satisfied..
- Thirdly, 3rd order harmonic mixing at B41 Rx would be caused by the leakage of 2nd harmonics of n77 Tx, which happens when 2x n77 Tx = 3x B41 Rx is satisfied..

Two MSDs for harmonic mixing are captured in Table 6.52.5-3 with uplink configuration in Table 6.52.5-4.

Note that these MSDs only happen when two bands are operated in asynchronous manner.

Table 6.52.5-1: MSD for reference sensitivity exceptions due to cross band isolation for EN-DC

Channel bandwidth											
EUTRA/NR DC Configuration	**EUTRA/NR band**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**40 MHz**	**50 MHz**	**60 MHz**	**80 MHz**	**100 MHz**	**Duplex mode**
CA_41A-n78A	41[1]	-93.5	-90.5	-88.7	-87.5						TDD
NOTE 1: Applicable only when harmonic mixing MSD for this combination is not applied.											

Table 6.52.5-2: Uplink configuration for reference sensitivity exceptions due to cross band isolation for EN-DC

UL band	DL band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz
n78	41	30	273	273	273	273	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 6.52.5-3: MSD for reference sensitivity exceptions due to receiver harmonic mixing for EN-DC in NR FR1

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)	100 MHz (dB)
41	n78[1]	N/A	8.3	8.0	6.9	N/A	3.9	3	2.3	1.2	0.4
n78	41[2]	10.4	10.4	10.4	10.4	N/A	N/A	N/A	N/A	N/A	N/A

NOTE 1: The requirements should be verified for UL EARFCN of the aggressor (lower) band (superscript LB) such that $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.15 \rfloor 0.1$ in MHz and $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$ 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 EARFCN of the aggressor (higher) band (superscript HB) such that $f_{UL}^{LB} = \lfloor 15 * f_{DL}^{HB} \rfloor 0.1$ in MHz and $F_{UL\_low}^{HB} + BW_{Channel}^{HB} / 2 \le f_{UL}^{HB} \le f_{UL\_high}^{HB} - BW_{Channel}^{HB} / 2$ with f_{DL}^{LB} carrier frequency in the victim (lower) band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the higher band.

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Table 6.52.5-4: Uplink configuration for reference sensitivity exceptions due to receiver harmonic mixing for EN-DC in NR FR1

UL band	DL band	SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz
41	n78	15	25	25	25	25	N/A	N/A	N/A	N/A	N/A	N/A
n78	41	30	N/A	50	50	50	N/A	50	50	50	50	50

6.52.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.52.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.52.6-1.

Table 6.52.6-1: Band 41 and Band n78 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_41A_n78A	41	a	3	b	0	2	n78	Harmonic mixing
	n78	c	0	d	-1			
	41	a	0	b	-2	3	41	Harmonic mixing
	n78	c	2	d	0			

Equations (6.52.6.1) and (6.52.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.52.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.52.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.52.6.2)$$

Formula (6.52.6.3-1) and (6.52.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.52.6.3\text{-}1)$$

$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.52.6.3\text{-}2)$$

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6.53 DC_41A-n79A

6.53.1 Operating bands for DC

Table 6.53.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band	Downlink (DL) band	Duplex mode
		BS receive / UE transmit	BS transmit / UE receive	
		FUL_low – FUL_high	FDL_low – FDL_high	
DC_41A-n79A	41	2496 MHz – 2690 MHz	2496 MHz – 2690 MHz	TDD
	n79	4400 MHz – 5000 MHz	4400 MHz – 5000 MHz	TDD

6.53.2 Channel bandwidths per operating band for DC

Table 6.53.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_41A-n79A	41	15	Yes	Yes	Yes	Yes						120
	n79	15					Yes	Yes				
		30					Yes	Yes	Yes	Yes	Yes	
		60					Yes	Yes	Yes	Yes	Yes	

6.53.3 Co-existence studies

Table 6.53.3-1 lists up to 7th order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 41+Band n79 2UL DC.

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Table 6.53.3-1: Band 41 and Band n79 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	2496	2690	4400	5000
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	4992-5380		8800-10000	
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	7488-8070		13200-15000	
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	9984-10760		17600-20000	
5th harmonics frequency limits	5*fx_low	5*fx_high	5*fy_low	5*fy_high
5th harmonics frequency limits (MHz)	12480-13450		22000-25000	
6th harmonics frequency limits	6*fx_low	6*fx_high	6*fy_low	6*fy_high
	14976-16140		26400-30000	
7th harmonics frequency limits	7*fx_low	7*fx_high	7*fy_low	7*fy_high
7th harmonics frequency limits (MHz)	17472-18830		30800-35000	
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	1710-2504		6896-7690	
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)	8-980		6110-7504	
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)	9392-10380		11296-12690	
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)	2396-2790		4380-5020	
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)	2488-3670		10510-12504	
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	5008-3420			
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)	11888-13070		15696-17690	
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	13792-15380			
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)	17504-14910		6360-4984	
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)	10008-7820		730-2512	
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)	20096-22690		14384-15760	
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)	18192-20380		16288-18070	

Based on Table 6.53.3-1,

- The 2nd harmonic of Band 41 may fall into Band n79 due to UE transmitting in the lower part of the Band 41. However, the lower part of Band 41 is only used in US where there is no plan on using n79. So the harmonic issue will not be a problem for this combination.

- The 2nd, 3rd, 4th and 5th order IMD may fall into Band 41 and the 3rd, 4th, 5th order IMD product may fall into Band n79. However it should be noted that IMD will not be an issue for TDD bands (no self-interference for the TDD band) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.53.3-2 lists if up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.53.3-2: Band 41 and Band n79 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		5th IMD
Galileo	1559	-	1591	Yes		5th IMD
GLONASS	1591	-	1610	Yes		5th IMD
GPS	1563	-	1587	Yes		5th IMD
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	2nd, 3rd, 4th, 5th IMD
	2400	-	2494	Yes	Asia	2nd, 3rd, 4th, 5th IMD
ISM band (5GHz)	5150	-	5925	Yes	US	2nd harmonic, 5th IMD
	5150	-	5350	Yes	Europe	2nd harmonic, 5th IMD
	5470	-	5725	Yes		5th IMD
	5150	-	5825	Yes	Asia	2nd harmonic, 5th IMD

Table 6.53.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.53.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_41A-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, n77, n78	FDL_low	-	FDL_high	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	Note 1
	NR Band n257, n258	FDL_low	-	FDL_high	[-5]	100	
NOTE 1: Applicable when co-existence with PHS system operating in 1884.5 -1915.7MHz.							

6.53.4 ΔTIB and ΔRIB values

For DC_41A-n79A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in Table 6.53.4-1 Table 6.53.4-2 for UEs not supporting simultaneous Tx/Rx.

Table 6.53.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_41A-n79A	41	0.3
	n79	0.8

Table 6.53.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_41A-n79A	41	0
	n79	0.5

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6.53.5 MSD

For DC 41A-n79, there are two operation modes, synchronous operation and asynchronous operation.

- In synchronous operation, there is no MSD issue as TX and RX slots between B41 and n79 are aligned.
- In asynchronous operation, there are small frequency ranges where large MSD occurs as shown in Table 6.53.5-1.

Table 6.53.5-1: MSD frequency range

MSD Issue	Band	Frequency Low MHz	Frequency high Mhz	comments
2nd harmonic B41 TX on n79 RX	B41	2496	2506	Small range of problematic frequencies but very large MSD (35.4 dB)
	n79	4992	5000	
n79 TX on 2nd harmonic mixing B41 RX	B41	2496	2506	Small range of problematic frequencies and significant MSD (13 dB)
	n79	4992	5000	

However, considering the current spectrum situation for n79 (China, Japan), the lowest edges of Band 41 actually used are far away from the range creating MSD issue.

- The lowest usable frequency is 2545MHz in Japan,
- The lowest usable frequency may go down to 2515 MHz in China (Note that 2500 - 2515 MHz may be considered as guard band for protection of services below 2500MHz.)

So the harmonic issue is not a problem for this combination considering the spectrum situation clarified above. No MSD needs to be specified for this combination. A note is proposed for TS38.101 Table 5.2B.3.1-1 “The frequency range below 2506 MHz for Band 41 is not used in this combination.”

6.53.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.53.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.53.6-1.

Table 6.53.6-1: Band 41 and Band n79 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_41A_n79A	41	a	2	b	0	2	n79	Harmonic
	n79	c	0	d	-1			

Equations (6.53.6.1) and (6.53.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.53.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.53.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.53.6.2)$$

Formula (6.53.6.3-1) and (6.53.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.53.6.3\text{-}1)$$

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$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX\,2}}{2} \quad (6.53.6.3\text{-}2)$$

6.54 DC_41A-n258A

6.54.1 Operating bands for DC

Table 6.34.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band	Downlink (DL) band	Duplex mode
		BS receive / UE transmit	BS transmit / UE receive	
		FUL_low – FUL_high	FDL_low – FDL_high	
DC_41A-n258A	41	2496 MHz – 2690 MHz	2496 MHz – 2690 MHz	TDD
	n258	24250 MHz – 27500 MHz	24250 MHz – 27500 MHz	TDD

6.54.2 Channel bandwidths per operating band for DC

Table 6.34.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	[50 MHz]	100 MHz	200 MHz	400 MHz	Maximum aggregated bandwidth [MHz]
DC_41A_n257	41	15	Yes	Yes	Yes	Yes					420
	n258	60					Yes	Yes	Yes		
		120					Yes	Yes	Yes	Yes	

6.54.3 Co-existence studies

Table 6.54.3-1 lists up to 7th order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 41+Band n258 2UL DC.

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Table 6.54.3-1: Band 41 and Band n258 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	2496	2690	24250	27500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	4992-5380		48500-55000	
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	7488-8070		72750-82500	
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	9984-10760		97000-110000	
5th harmonics frequency limits	5*fx_low	5*fx_high	5*fy_low	5*fy_high
5th harmonics frequency limits (MHz)	12480-13450		121250-137500	
6th harmonics frequency limits	6*fx_low	6*fx_high	6*fy_low	6*fy_high
6th harmonics frequency limits (MHz)	14976-16140		145500-165000	
7th harmonics frequency limits	7*fx_low	7*fx_high	7*fy_low	7*fy_high
7th harmonics frequency limits (MHz)	17472-18830		169750-192500	
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	21560-25004		26746-30190	
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)	18870-22508		45810-52504	
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)	29242-32880		50996-57690	
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)	2296-2890		24230-27520	
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)	16180-20012		70060-80004	
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	43120-50008			
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)	31738-35570		75246-85190	
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	53492-60380			
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)	94310-107504		13490-17516	
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)	67370-77508		40430-47512	
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)	99496-112690		34234-38260	
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)	77742-87880		55988-63070	

Based on Table 6.54.3-1, the 2nd and 3rd order IMD may fall into Band n258 and 3rd order IMD product may fall into Band 41. However it should be noted that IMD will not be an issue for TDD bands (no self-interference for the TDD band) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.54.3-2 lists if up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.54.3-2: Band 41 and Band n258 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	3rd IMD
	2400	-	2494	Yes	Asia	3rd IMD
ISM band (5GHz)	5150	-	5925	Yes	US	2nd harmonic
	5150	-	5350	Yes	Europe	2nd harmonic
	5470	-	5725	No		
	5150	-	5825	Yes	Asia	2nd harmonic

Table 6.54.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_41A-n258A	E-UTRA Band 1, 3, 8, 34, 39, 40, 44, 45	FDL_low	-	FDL_high	-50	1	
	NR Band n78, n79	FDL_low	-	FDL_high	-50	1	

6.54.4 ΔTIB and ΔRIB values

For DC_41A_n258A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.54.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_41A_n258	41	0
	n258	0

Table 6.54.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_41A_n258	41	0
	N258	0

6.54.5 MSD

No IMD issue is identified for this combination.

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6.55 DC_42A_n257

6.55.1 Operating bands for DC

Table 6.55.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_42A_n257	42	3400MHz – 3600 MHz	3400MHz – 3600 MHz	TDD
	n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD

6.55.2 Channel bandwidths per operating band for DC

Table 6.55.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	[50 MHz]	100 MHz	200 MHz	400 MHz	Maximum aggregated bandwidth [MHz]
DC_42A_n257A	42	15	Yes	Yes	Yes	Yes					420
	n257	60					Yes	Yes	Yes		
		120					Yes	Yes	Yes	Yes	
DC_42A_n257D	42	15	Yes	Yes	Yes	Yes					420
	n257	See CA_n257D in Table 5.5A1-2 in TS 38.101-2 [4]									
DC_42A_n257E	42	15	Yes	Yes	Yes	Yes					620
	n257	See CA_n257E in Table 5.5A1-2 in TS 38.101-2 [4]									
DC_42A_n257F	42	15	Yes	Yes	Yes	Yes					820
	n257	See CA_n257F in Table 5.5A1-2 in TS 38.101-2 [4]									

6.55.3 Co-existence studies

Table 6.55.3-1 lists Band 42 +Band n257 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.55.3-1: Band 42 and Band n257 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	3400	3600	26500	29500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	6800	7200	53000	59000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	10200	10800	79500	88500
2nd order IMD products	(f2_low – f1_high)	(f2_high – f1_low)	(f2_low + f1_low)	(f2_high + f1_high)
IMD frequency limits (MHz)	22900	26100	29900	33100
Two-tone 3rd order IMD products	|f2_high – 2*f1_low|	|f2_low – 2*f1_high|	(2*f2_low – f1_high)	(2*f2_high – f1_low)
IMD frequency limits (MHz)	19300	22700	49400	55600
Two-tone 3rd order IMD products	(2*f1_low + f2_low)	(2*f1_high + f2_high)	(2*f2_low + f1_low)	(2*f2_high + f1_high)
IMD frequency limits (MHz)	33300	36700	56400	62600
Two-tone 3rd order IMD products	(f1_low – max BW f2)	(f1_high + max BW f2)	(f2_low – max BW f1)	(f2_high + max BW f1)
IMD frequency limits (MHz)	3000	4000	26480	29520
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)	15700	19300	75900	85100
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	45800	52200		
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)	36700	40300	82900	92100
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	59800	66200		
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)	102400	114600	12100	15900
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)	72300	81700	42200	48800
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)	109400	121600	40100	43900
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)	86300	95700	63200	69800

Based on Table 6.55.3-1;

- 2nd order IMD may also fall into Rx frequencies of bands n258
- 3rd order IMD may also fall into Rx frequencies of bands 22, 42, 43, 48, n77, n78, n257 and n258

When 2UL inter-band DC UE is operating with other systems such as Wi-Fi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.55.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.55.3-2: 2UL Band 42 +Band n257 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	

Table 6.55.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.55.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_42A-n257A	E-UTRA Band 1, 3, 5, 8, 11, 18, 19, 21, 28, 34, 39, 40, 41, 65	F_{DL_low}	-	F_{DL_high}	-50	1	

6.55.4 ΔT_{IB} and ΔR_{IB} values

For DC_42A_n257, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.55.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_42A_n257	42	0
	n257	0

Table 6.55.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_42A_n257	42	0
	n257	0

6.55.5 MSD

No IMD issues are expected for DC configuration between the LTE bands below 6GHz and FR2 NR band. Furthermore, up to 7th order harmonics have no impact to Rx frequency of both LTE and NR bands.

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6.56 DC_1A_n28

6.56.1 Operating bands for DC

Table 6.56.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band BS receive / UE transmit $F_{UL\_low} – F_{UL\_high}$	Downlink (DL) band BS transmit / UE receive $F_{DL\_low} – F_{DL\_high}$	Duplex mode
DC_1A_n28[1]	1	1920 MHz – 1980 MHz	2110 MHz – 2170 MHz	FDD
	n28	703 MHz – 748 MHz	758 MHz – 803 MHz	FDD
Note 1: The frequency range in band 28 is restricted for this band combination to 703-733 MHz for the UL and 758-788 MHz for the DL.				

6.56.2 Channel bandwidths per operating band for DC

Table 6.56.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

	DC operating / channel bandwidth											
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_1A_n28	1	15	Yes	Yes	Yes	Yes						40
	n28	15	Yes	Yes	Yes	Yes						
		30		Yes	Yes	Yes						
		60										

6.56.3 Co-existence studies

Table 6.56.3-1 lists 1A+n28 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.56.3-1: Band 1 and Band n28 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fn_low	fn_high
UL frequency (MHz)	703	733	1920	1980
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fn_low	2* fn_high
2nd harmonics frequency limits (MHz)	1406 – 1466		3840 – 3960	
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fn_low	3* fn_high
3rd harmonics frequency limits (MHz)	2109 – 2199		5760 – 5940	
2nd order IMD products	|fn_low – fx_high|	|fn_high – fx_low|	|fn_low + fx_low|	|fn_high + fx_high|
IMD frequency limits (MHz)	1187 – 1277		2623 – 2713	
Two-tone 3rd order IMD products	|2*fx_low – fn_high|	|2*fx_high – fn_low|	|2*fn_low – fx_high|	|2*fn_high – fx_low|
IMD frequency limits (MHz)	454 – 574		3107 – 3257	
Two-tone 3rd order IMD products	|2*fx_low + fn_low|	|2*fx_high + fn_high|	|2*fn_low + fx_low|	|2*fn_high + fx_high|
IMD frequency limits (MHz)	3326 – 3446		4543 – 4693	
Two-tone 3rd order IMD products	(fx_low – max BW fn)	(fx_high + max BW fn)	(fn_low – max BW fx)	(fn_high + max BW fx)
IMD frequency limits (MHz)	683 – 753		1900 – 2000	
Two-tone 4th order IMD products	|3*fx_low –1* fn_high|	|3*fx_high – 1*fn_low|	|3*fn_low – 1*fx_high|	|3*fn_high – 1*fx_low|
IMD frequency limits (MHz)	129 – 279		5027 – 5237	
Two-tone 4th order IMD products	|2*fx_low –2* fn_high|	|2*fx_high –2* fn_low|		
IMD frequency limits (MHz)	2374 – 2554			
Two-tone 4th order IMD products	|3*fx_low +1* fn_low|	|3*fx_high + 1*fn_high|	|3*fn_low + 1*fx_low|	|3*fn_high + 1*fx_high|
IMD frequency limits (MHz)	4029 – 4179		6463 – 6673	
Two-tone 4th order IMD products	|2*fx_low +2* fn_low|	|2*fx_high +2* fn_high|		
IMD frequency limits (MHz)	5246 – 5426			
Two-tone 5th order IMD products	|fx_low – 4*fn_high|	|fx_high – 4*fn_low|	|fn_low – 4*fx_high|	|fn_high – 4*fx_low|
IMD frequency limits (MHz)	6947 – 7217		832 – 1012	
Two-tone 5th order IMD products	|2*fx_low - 3*fn_high|	|2*fx_high - 3*fn_low|	|2*fn_low - 3*fx_high|	|2*fn_high - 3*fx_low|
IMD frequency limits (MHz)	4294 – 4534		1641 – 1851	
Two-tone 5th order IMD products	|fx_low + 4*fn_low|	|fx_high + 4*fn_high|	|fn_low + 4*fx_low|	|fn_high + 4*fx_high|
IMD frequency limits (MHz)	8383 – 8653		4732 – 4912	
Two-tone 5th order IMD products	|2*fx_low + 3*fn_low|	|2*fx_high + 3*fn_high|	|2*fn_low + 3*fx_low|	|2*fn_high + 3*fx_high|
IMD frequency limits (MHz)	7166 – 7406		5949 – 6159	

Based on Table 6.56.3-1,

- 2nd order harmonics may fall into Rx frequencies of Band 32, 45, 50, 51, 75, 76, and n77
- 3rd order harmonics may fall into Rx frequencies of Band 1, 4, 10, 23, 46, 47, 65, and 66
- 2nd order IMD may fall into Rx frequencies of Band 7 and 41
- 3rd order IMD may fall into Rx frequencies of Band 2, 12, 13, 17, 25, 29, 31, 33, 35, 36, 37, 39, 42, 44, 67, 68, n77, and n78
- 4th order IMD may fall into Rx frequencies of Band 30, 40, 41, 46, and n77
- 5th order IMD may fall into Rx frequencies Band 3, 5, 6, 8, 9, 18, 19, 26, 27, 35, and n79

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Tables 6.56.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.56.3-2: 2UL Band 1 + Band n28 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD4
	2400	-	2494	Yes	Asia	IMD4
ISM band (5GHz)	5150	-	5925	Yes	US	H3, IMD4
	5150	-	5350	Yes	Europe	IMD4
	5470	-	5725	No		
	5150	-	5825	Yes	Asia	H3, IMD4

Table 6.X.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.X.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission				
	Protected band	Frequency range (MHz)	Maximum Level (dBm)	MBW (MHz)	NOTE

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DC_1A-n28A	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	2
	NR band n3, n34	F_{DL_low}	-	F_{DL_high}	-50	1	3
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	5, 21
	E-UTRA Band 65 NR band n1	F_{DL_low}	-	F_{DL_high}	-50	1	5, 6
	Frequency range	470	-	694	-42	8	3, 22
	Frequency range	470	-	710	-26.2	6	23
	Frequency range	758	-	773	-32	1	3
	Frequency range	773	-	803	-50	1	
	Frequency range	662	-	694	-26.2	6	3
	Frequency range	1880		1895	-40	1	3,12
	Frequency range	1895		1915	-15.5	5	3, 12, 13
	Frequency range	1915		1920	+1.6	5	3, 12, 13
	Frequency range	1839.9	-	1879.9	-50	1	3
	Frequency range	1884.5	-	1915.7	-41	0.3	5, 7

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. In case the exceptions are allowed 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 or 4 for the 2nd, 3rd or 4th 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 TS 36.101 [2] Table 6.6.3.1-1 and TS 36.101 [2] Table 6.6.3.1A-1 in from the edge of the aggregated channel bandwidth.

NOTE 5: 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 6: 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 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 7: Applicable when NS_05 in section 6.6.3.3.1 is signalled by the network.

NOTE 12: 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.

NOTE13: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.

NOTE 21: 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 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 22: 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.

NOTE 23: 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.

6.56.4 ΔT_{IB} and ΔR_{IB} values

For DC_1A-n28A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

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Table 6.56.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_1A-n28A	1	0.3
	n28	0.6

Table 6.56.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_1A-n28A	1	0
	n28	0.2

6.56.5 MSD

Table 6.56.5-1 lists the MSD required for the dual connectivity configuration due to 3rd harmonic of Band n28, reusing values specified in LTE for CA_1A-28A..

Table 6.56.5-1: MSD due to 3rd harmonic issue for DC_1A-n28A

MSD due to harmonic exception for the DL band					
UL band	**DL band**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
		dB	**dB**	**dB**	**dB**
n28	1[1,2,3]	[10.2]	[7.6]	[6.2]	[5.3]

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 $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.3 \rfloor 0.1$ in MHz and $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$ 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.

NOTE 3: Applicable for the operations with 2 or 4 antenna ports supported in the band with carrier aggregation configured.

Table 6.56.5-2 Uplink configuration for the low band (exceptions due to harmonic issue)

E-UTRA Band / Channel bandwidth of the high band / N_{RB} / Duplex mode						
LTE-NR DC band combination	**UL band**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**Duplex mode**
DC_1A-n28A	n28	8	16	25	25	FDD

6.56.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.56.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.56.6-1.

Table 6.56.6-1: Band 1 and Band n28 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_1A_n28A	1	a	0	b	-1	3	1	Harmonic
	n28	c	3	d	0			

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Equations (6.56.6.1) and (6.56.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.56.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.56.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.56.6.2)$$

Formula (6.56.6.3-1) and (6.56.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.56.6.3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.56.6.3\text{-}2)$$

6.57 DC_3A_n7A

6.57.1 Operating bands for DC

Table 6.57.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_3_n7	3	1710 MHz – 1785MHz	1805 MHz – 1880 MHz	FDD
	n7	2500 MHz – 2570 MHz	2620 MHz – 2690 MHz	FDD

6.57.2 Channel bandwidths per operating band for DC

Table 6.57.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth													
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	35 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Maximum aggregated bandwidth [MHz]
DC_3A_n7A	3	15	Yes	Yes	Yes	Yes							70
	n7	15	Yes	Yes	Yes	Yes	Yes		Yes				
		30		Yes	Yes	Yes	Yes		Yes				
		60		Yes	Yes	Yes	Yes		Yes				

6.57.3 Co-existence studies

For Band 3 +Band n7 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order intermodulation products for the UE coexistence analysis were calculated and listed in Table 6.57.3-1.

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Table 6.57.3-1: Harmonic and IMD analysis

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1710	1785	2500	2570
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3420	3570	5000	5140
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5130	5355	7500	7710
Two tone 2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	715	860	4210	4355
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)	850	1070	3215	3430
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)	5920	6140	6710	6925
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)	2560	2855	5715	6000
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)	7630	7925	9210	9495
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 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 6.57.3-1;

- There is no harmonic issue at legacy E-UTRA bands and NR band n7
- 2nd order IMD may also fall into B12, B13, B14, B17, B20, B26, B27 B28, B29, B67, B68 and TDD B44, n79.
- 3rd order IMD may also fall into B5, B6, B8, B18, B19, B26, B27 and TDD B42, B46, B47, n77, n78.
- 4th order IMD may also fall into B7, B11, B21, B32, B69, B74, B75, B76 and TDD B38, B41, B45, B46, B47, B50, B51.
- 5th order IMD may also fall into TDD n77, n79.

The 4th IMD will be impact to the own received band n7.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.57.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.57.3-2: 2UL Band 3 +Band n7 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD4
Galileo	1559	-	1591	Yes		IMD4
GLONASS	1591	-	1610	Yes		IMD4
GPS	1563	-	1587	Yes		IMD4
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	-
ISM band (5GHz)	5150	-	5925	-	US	-
	5150	-	5350	Yes	Europe	3rd order harmonic B3
	5470	-	5725	Yes		IMD4
	5150	-	5825	Yes	Asia	3rd order harmonic B3, IMD4

Table 6.57.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.57.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_3A_n7A	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 NR Band n1, n5, n7, n8, n20, n28, n50, n51, n74, n75, n76	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA band 3	F_{DL_low}	-	F_{DL_high}	-50	1	3
	E-UTRA band 22, 42	F_{DL_low}	-	F_{DL_high}	-50	1	2
	Frequency range	2570	-	2575	+1.6	5	3, 13, 14
	Frequency range	2575	-	2595	-15.5	5	3, 13, 14
	Frequency range	2595	-	2620	-40	1	3, 14

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. In case the exceptions are allowed 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 or 4 for the 2nd, 3rd or 4th 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 TS 36.101 [2] Table 6.6.3.1-1 and TS 36.101 [2] Table 6.6.3.1A-1 in from the edge of the aggregated channel bandwidth.

NOTE13: 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 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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6.57.4 ΔT_{IB} and ΔR_{IB} values

For DC_3A-n7A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.57.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_3A-n7A	3	0.5
	n7	0.5

Table 6.57.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_3A-n7A	3	0
	n7	0

6.57.5 MSD

Table 6.57.5-1 lists the MSD required for the dual connectivity configuration.

Table 6.57.5-1: MSD for the DC configuration

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_3A-n7A	3	1730	5	25	1825	N/A	FDD	4th IMD
	n7	2535	10	52	2655	[10.25]	FDD	

6.57.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.57.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.57.6-1.

Table 6.57.6-1: Band 3 and Band n7 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_3A_n7A	3	a	3	b	0	4	n7	IMD
	n7	c	-1	d	-1			

Equations (6.57.6.1) and (6.57.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.57.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.57.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.57.6.2)$$

Formula (6.57.6.3-1) and (6.57.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

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$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.57.6.3\text{-}1)$$

$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.57.6.3\text{-}2)$$

6.58 DC_3A_n28

6.58.1 Operating bands for DC

Table 6.58.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band BS receive / UE transmit F_{UL_low} – F_{UL_high}	Downlink (DL) band BS transmit / UE receive F_{DL_low} – F_{DL_high}	Duplex mode
DC_3A_n28[1]	3	1710 MHz – 1785 MHz	1805 MHz – 1880 MHz	FDD
	n28	703 MHz – 748 MHz	758 MHz – 803 MHz	FDD
Note 1: The frequency range in band 28 is restricted for this band combination to 703-733 MHz for the UL and 758-788 MHz for the DL.				

6.58.2 Channel bandwidths per operating band for DC

Table 6.58.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

	DC operating / channel bandwidth											
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_3A_n28	3	15	Yes	Yes	Yes	Yes						30
	n28	15	Yes	Yes	Yes	Yes						
		30		Yes	Yes	Yes						
		60										

6.58.3 Co-existence studies

Table 6.58.3-1 lists 3A+n28 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.58.3-1: Band 3 and Band n28 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fn_low	fn_high
UL frequency (MHz)	703	733	1710	1785
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fn_low	2* fn_high
2nd harmonics frequency limits (MHz)	1406 – 1466		3420 – 3570	
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fn_low	3* fn_high
3rd harmonics frequency limits (MHz)	2109 – 2199		5130 – 5355	
2nd order IMD products	|fn_low – fx_high|	|fn_high – fx_low|	|fn_low + fx_low|	|fn_high + fx_high|
IMD frequency limits (MHz)	977 – 1082		2413 – 2518	
Two-tone 3rd order IMD products	|2*fx_low – fn_high|	|2*fx_high – fn_low|	|2*fn_low – fx_high|	|2*fn_high – fx_low|
IMD frequency limits (MHz)	244 – 379		2687 – 2867	
Two-tone 3rd order IMD products	|2*fx_low + fn_low|	|2*fx_high + fn_high|	|2*fn_low + fx_low|	|2*fn_high + fx_high|
IMD frequency limits (MHz)	3116 – 3251		4123 – 4303	
Two-tone 3rd order IMD products	(fx_low – max BW fn)	(fx_high + max BW fn)	(fn_low – max BW fx)	(fn_high + max BW fx)
IMD frequency limits (MHz)	683 – 753		1690 – 1805	
Two-tone 4th order IMD products	|3*fx_low –1* fn_high|	|3*fx_high – 1*fn_low|	|3*fn_low – 1*fx_high|	|3*fn_high – 1*fx_low|
IMD frequency limits (MHz)	324 – 489		4397 – 4652	
Two-tone 4th order IMD products	|2*fx_low –2* fn_high|	|2*fx_high –2* fn_low|		
IMD frequency limits (MHz)	1954 – 2164			
Two-tone 4th order IMD products	|3*fx_low +1* fn_low|	|3*fx_high + 1*fn_high|	|3*fn_low + 1*fx_low|	|3*fn_high + 1*fx_high|
IMD frequency limits (MHz)	3819 – 3984		5833 – 6088	
Two-tone 4th order IMD products	|2*fx_low +2* fn_low|	|2*fx_high +2* fn_high|		
IMD frequency limits (MHz)	4826 – 5036			
Two-tone 5th order IMD products	|fx_low – 4*fn_high|	|fx_high – 4*fn_low|	|fn_low – 4*fx_high|	|fn_high – 4*fx_low|
IMD frequency limits (MHz)	6107 – 6437		1027 – 1222	
Two-tone 5th order IMD products	|2*fx_low - 3*fn_high|	|2*fx_high - 3*fn_low|	|2*fn_low - 3*fx_high|	|2*fn_high - 3*fx_low|
IMD frequency limits (MHz)	3664 – 3949		1221 – 1461	
Two-tone 5th order IMD products	|fx_low + 4*fn_low|	|fx_high + 4*fn_high|	|fn_low + 4*fx_low|	|fn_high + 4*fx_high|
IMD frequency limits (MHz)	7543 – 7873		4522 – 4717	
Two-tone 5th order IMD products	|2*fx_low + 3*fn_low|	|2*fx_high + 3*fn_high|	|2*fn_low + 3*fx_low|	|2*fn_high + 3*fx_high|
IMD frequency limits (MHz)	6536 – 6821		5529 – 5769	

Based on Table 6.58.3-1,

- 2nd order harmonics may fall into Rx frequencies of Band 22, 32, 42, 45, 48, 50, 51, 75, 76, n77, and n78
- 3rd order harmonics may fall into Rx frequencies of Band 1, 4, 10, 23, 46, 65, and 66
- 2nd order IMD may fall into Rx frequencies of Band 41
- 3rd order IMD may fall into Rx frequencies of Band 7, 12, 13, 17, 29, 41, 44, 67, 68, and n77
- 4th order IMD may fall into Rx frequencies of Band 1, 2, 4, 10, 25, 31, 36, 65, 66, 70, n77, and n79
- and 5th order IMD may fall into Rx frequencies of Band 32, 43, 45, 46, 50, 51, 75, 76, n77, n78, and n79

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.58.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.58.3-2: 2UL Band 3 + Band n28 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD2
	2400	-	2494	Yes	Asia	IMD2
ISM band (5GHz)	5150	-	5925	Yes	US	H3, IMD4, IMD5
	5150	-	5350	Yes	Europe	H3
	5470	-	5725	Yes		IMD5
	5150	-	5825	Yes	Asia	H3, IMD5

Table 6.58.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.58.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission				
	Protected band	Frequency range (MHz)	Maximum Level (dBm)	MBW (MHz)	NOTE

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DC_3A-n28A	E-UTRA Band 42, 43, 65 NR band n1, n50, n51, n74, n75, n76, n78	F_{DL_low}	-	F_{DL_high}	-50	1	2
	NR band n1	F_{DL_low}	-	F_{DL_high}	-50	1	5, 6
	NR band n3	F_{DL_low}	-	F_{DL_high}	-50	1	3
	E-UTRA Band 27, 31, 72 NR band n5, n7, n8, n20, n26, n34, n38, n40, n41	F_{DL_low}	-	F_{DL_high}	-50	1	
	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	10
	Frequency range	470	-	710	-26.2	6	23
	Frequency range	758	-	773	-32	1	3
	Frequency range	773	-	803	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	4, 5

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. In case the exceptions are allowed 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 or 4 for the 2nd, 3rd or 4th 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 TS 36.101 [2] Table 6.6.3.1-1 and TS 36.101 [2] Table 6.6.3.1A-1 in from the edge of the aggregated channel bandwidth.

NOTE 4: Applicable when co-existence with PHS system operating in 1884.5 -1915.7MHz.

NOTE 5: 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 6: 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 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).

NOTE10: This requirement applies for 5, 10, 15 and 20 MHz E-UTRA channel bandwidth allocated within 1744.9MHz and 1784.9MHz.

NOTE 23: 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.

6.58.4 ΔT_{IB} and ΔR_{IB} values

For DC_3A-n28A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.58.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_3A-n28A	3	0.3
	n28	0.3

Table 6.58.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_3A-n28A	3	0
	n28	0

6.58.5 MSD

Based on co-existence studies of band 3 + band n28, there is no harmonic and IMD falling into own receive bands. Thus, no MSD is required for this combination.

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6.59 DC_5A-n78A

6.59.1 Operating bands for DC

Table 6.59.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_5A-n78A	5	824 MHz – 849 MHz	869 MHz – 894 MHz	FDD
	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD

6.59.2 Channel bandwidths per operating band for DC

Table 6.59.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

	DC operating / channel bandwidth											
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_5A-n78A	5	15	Yes	Yes								110
	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	

6.59.3 Co-existence studies

Tables 6.59.3-1 lists Band 5A + Band n78A 2UL DC 2nd, 3rd, 4th and 5th order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.59.3-1: Band 5 and Band n78 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	824	849	3300	3800
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1648	1698	6600	7600
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2472	2547	9900	11400
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	3296	3396	13200	15200
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	4120	4245	16500	19000
2nd 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 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)	2152	1602	5751	6776
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)	4948	5498	7424	8449
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)	724	949	3290	3810
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)	1328	753	9051	10576
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	5952	4902		
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)	5772	6347	10724	12249
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	8248	9298		
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)	14376	12351	96	504
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)	9752	8202	4053	5128
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)	14024	16049	6596	7196
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)	11548	13098	9072	10147

Based on Table 6.59.3-1,

- 3rd order harmonic may fall into Rx frequencies of band 41
- 4th order harmonic may fall into Rx frequencies of bands n77 and n78.
- 5th order harmonic may fall into Rx frequencies of band n77.
- 2nd order IMD may also fall into own Rx of band n78 and Rx frequencies of bands 7, 38, 41, 69 and n79
- 3rd order IMD may also fall into own Rx of bands 5 and n78 and Rx frequencies of bands 1, 2, 3, 4, 6, 8, 9, 10, 12, 13, 14, 17, 18, 19, 20, 22, 25, 26, 27, 28, 29, 33, 34, 35, 36, 37, 39, 42, 43, 44, 46, 47, 48, 65, 66, 67, 68, 70, n77 and n79
- 4th order IMD may also fall into own Rx of band 5 and Rx frequencies of bands 6, 8, 13, 14, 18, 19, 20, 26, 27, 28, 44, 46, 47, 67, 68 and n79

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- 5th order IMD may also fall into Rx frequencies of bands 31, n77 and n79

When 2UL inter-band DC UE is operating with other systems such as Wi-Fi, Bluetooth and GNSS; the harmonics and intermodulation products can have impact on these systems. Table 6.59.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.59.3-2: 2UL Band 5 + Band n78 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD2
	2400	-	2494	Yes	Asia	IMD2
ISM band (5GHz)	5150	-	5925	Yes	US	IMD3, 4
	5150	-	5350	Yes	Europe	IMD3, 4
	5470	-	5725	Yes		IMD3, 4
	5150	-	5825	Yes	Asia	IMD3

Table 6.59.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.59.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission				
	Protected band	Frequency range (MHz)	Maximum Level (dBm)	MBW (MHz)	NOTE

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DC_5A_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	
	Frequency range	3800	-	3805	+1.6	5	1, 2, 3
	Frequency range	3805	-	3825	-15.5	5	1, 2, 3
	Frequency range	3825	-	3850	-40	1	1, 3
	Frequency range	3850	-	4200	-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	4, 5
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	
	E-UTRA Band 41	F_{DL_low}	-	F_{DL_high}	-50	1	6
	E-UTRA Band 18, 19	F_{DL_low}	-	F_{DL_high}	-40	1	5
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	5
NOTE 1: 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.							
NOTE 2: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.							
NOTE 3: The requirement is applicable for any channel bandwidths within the range 3300 - 3800 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range [TBD – 3792.5] MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range [TBD – 3790] MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to [TBD] RB.							
NOTE 4: Applicable when co-existence with PHS system operating in 1884.5 -1915.7MHz							
NOTE 5: Applicable only when the assigned E-UTRA carrier is confined within 824 MHz and 849 MHz for UE category M1, M2 and UE category NB1 and NB2.							
NOTE 6: 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.							

6.59.4 ΔT_{IB} and ΔR_{IB} values

For DC_5A-n78A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.59.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_5A-n78A	5	0.6
	n78	0.8

Table 6.59.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_5A-n78A	5	0.2
	n78	0.5

6.59.5 MSD

Table 6.59.5-1 lists the MSD required for the dual connectivity configuration.

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Table 6.59.5-1: MSD for the DC configuration

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_5A_n78A	5	844	5	25	889	8.3	FDD	IMD4 $\lvert f_{B78}-3*f_{B5}\rvert$
	n78	3421	10	52	3421	N/A	TDD	N/A

Table 6.59.5-2: MSD due to 4th harmonic for DC_5A-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
5	n78[1,2]		10.5	8.9	7.8		5.4				
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 4th 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 $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.4 \rfloor 0.1$ in MHz and $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$ 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 6.59.5-3 lists the UL configuration for the EN-DC configuration DC_5A-n78A.

Table 6.59.5-3: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for EN-DC in NR 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
5	n78	8	16	25	25[1], 25[2]						
NOTE 1: The configuration is used for measurement of MSD for NR channel bandwidth of 20MHz.											
NOTE 2: The configuration is used for measurement of MSD for NR channel bandwidth of 40MHz.											

6.60 DC_7A_n28

6.60.1 Operating bands for DC

Table 6.60.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band BS receive / UE transmit F_{UL_low} – F_{UL_high}	Downlink (DL) band BS transmit / UE receive F_{DL_low} – F_{DL_high}	Duplex mode
DC_7A_n28[1]	7	2500 MHz – 2570 MHz	2620 MHz – 2690 MHz	FDD
	n28	703 MHz – 748 MHz	758 MHz – 803 MHz	FDD
Note 1: The frequency range in band 28 is restricted for this band combination to 703-733 MHz for the UL and 758-788 MHz for the DL.				

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6.60.2 Channel bandwidths per operating band for DC

Table 6.60.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

	DC operating / channel bandwidth											
E-UTRA and NR DC Configuration	**E-UTRA and NR 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]**
DC_7A_n28	7	15		Yes	Yes	Yes						40
	n28	15	Yes	Yes	Yes	Yes						
		30		Yes	Yes	Yes						
		60										

6.60.3 Co-existence studies

Table 6.60.3-1 lists 7A+n28 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.60.3-1: Band 7 and Band n28 UL harmonics and IMD products

UE UL carriers	**fx_low**	**fx_high**	**fn_low**	**fn_high**
UL frequency (MHz)	703	733	2500	2570
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fn_low	2* fn_high
2nd harmonics frequency limits (MHz)	1406 – 1466		5000 – 5140	
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fn_low	3* fn_high
3rd harmonics frequency limits (MHz)	2109 – 2199		7500 – 7710	
2nd order IMD products	|fn_low – fx_high|	|fn_high – fx_low|	|fn_low + fx_low|	|fn_high + fx_high|
IMD frequency limits (MHz)	1767 – 1867		3203 – 3303	
Two-tone 3rd order IMD products	|2*fx_low – fn_high|	|2*fx_high – fn_low|	|2*fn_low – fx_high|	|2*fn_high – fx_low|
IMD frequency limits (MHz)	1034 – 1164		4267 – 4437	
Two-tone 3rd order IMD products	|2*fx_low + fn_low|	|2*fx_high + fn_high|	|2*fn_low + fx_low|	|2*fn_high + fx_high|
IMD frequency limits (MHz)	3906 – 4036		5703 – 5873	
Two-tone 3rd order IMD products	(fx_low – max BW fn)	(fx_high + max BW fn)	(fn_low – max BW fx)	(fn_high + max BW fx)
IMD frequency limits (MHz)	683 – 753		2480 – 2590	
Two-tone 4th order IMD products	|3*fx_low –1* fn_high|	|3*fx_high – 1*fn_low|	|3*fn_low – 1*fx_high|	|3*fn_high – 1*fx_low|
IMD frequency limits (MHz)	301 – 461		6767 – 7007	
Two-tone 4th order IMD products	|2*fx_low –2* fn_high|	|2*fx_high –2* fn_low|		
IMD frequency limits (MHz)	3534 – 3734			
Two-tone 4th order IMD products	|3*fx_low +1* fn_low|	|3*fx_high + 1*fn_high|	|3*fn_low + 1*fx_low|	|3*fn_high + 1*fx_high|
IMD frequency limits (MHz)	4609 – 4769		8203 – 8443	
Two-tone 4th order IMD products	|2*fx_low +2* fn_low|	|2*fx_high +2* fn_high|		
IMD frequency limits (MHz)	6406 – 6606			
Two-tone 5th order IMD products	|fx_low – 4*fn_high|	|fx_high – 4*fn_low|	|fn_low – 4*fx_high|	|fn_high – 4*fx_low|
IMD frequency limits (MHz)	9267 – 9577		242 – 432	
Two-tone 5th order IMD products	|2*fx_low - 3*fn_high|	|2*fx_high - 3*fn_low|	|2*fn_low - 3*fx_high|	|2*fn_high - 3*fx_low|
IMD frequency limits (MHz)	6034 – 6304		2801 – 3031	
Two-tone 5th order IMD products	|fx_low + 4*fn_low|	|fx_high + 4*fn_high|	|fn_low + 4*fx_low|	|fn_high + 4*fx_high|
IMD frequency limits (MHz)	10703 – 11013		5312 – 5502	
Two-tone 5th order IMD products	|2*fx_low + 3*fn_low|	|2*fx_high + 3*fn_high|	|2*fn_low + 3*fx_low|	|2*fn_high + 3*fx_high|
IMD frequency limits (MHz)	8906 – 9176		7109 – 7339	

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Based on Table 6.60.3-1,

- 2nd order harmonics may fall into Rx frequencies of Band 32, 45, 50, 51, 75, and 76
- 3rd order harmonics may fall into Rx frequencies of Band 1, 4, 10, 23, 65, and 66
- 2nd order IMD may fall into Rx frequencies of Band 3, 35, n77, and n78
- 3rd order IMD may fall into Rx frequencies of Band 12, 13, 17, 29, 38, 41, 44, 46, 47, 67, 68, 69, n77, and n79
- 4th order IMD may fall into Rx frequencies of Band 22, 42, 43, 48, n77, n78, and n79
- 5th order IMD may fall into Rx frequencies of Band 46

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.60.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.60.3-2: 2UL Band 7 + Band n28 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	Yes	Asia	IMD3
ISM band (5GHz)	5150	-	5925	Yes	US	IMD5
	5150	-	5350	Yes	Europe	IMD5
	5470	-	5725	Yes		IMD5
	5150	-	5825	Yes	Asia	IMD5

Table 6.60.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.60.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission				
	Protected band	Frequency range (MHz)	Maximum Level (dBm)	MBW (MHz)	NOTE

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DC_7A-n28A	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	2
	NR band n1	F_{DL_low}	-	F_{DL_high}	-50	1	5, 6
	Frequency range	758	-	773	-32	1	3
	Frequency range	773	-	803	-50	1	
	Frequency range	2570	-	2575	+1.6	5	3, 13, 14
	Frequency range	2575	-	2595	-15.5	5	3, 13, 14
	Frequency range	2595	-	2620	-40	1	3, 14

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. In case the exceptions are allowed 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 or 4 for the 2nd, 3rd or 4th 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 TS 36.101 [2] Table 6.6.3.1-1 and TS 36.101 [2] Table 6.6.3.1A-1 in from the edge of the aggregated channel bandwidth.

NOTE 5: 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 6: 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 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).

NOTE13: 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 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.

6.60.4 ΔT_{IB} and ΔR_{IB} values

For DC_7A-n28A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.60.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_7A-n28A	7	0.3
	n28	0.3

Table 6.60.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_7A-n28A	7	0
	n28	0

6.60.5 MSD

Based on co-existence studies of band 7 + band n28, there is no harmonic and IMD falling into own receive bands. Thus, no MSD is required for this combination.

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6.61 DC_7A-n257A

6.61.1 Operating bands for DC

Table 6.61.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_7A-n257A	7	2500 MHz – 2570 MHz	2620 MHz – 2690 MHz	FDD
	n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD

6.61.2 Channel bandwidths per operating band for DC

Table 6.61.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth											
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	50 MHz	100 MHz	[200 MHz]	400 MHz	Maximum aggregated bandwidth [MHz]
DC_7A-n257A	7	15	Yes	Yes	Yes	Yes					420
	n257	60					Yes	Yes	Yes		
		120					Yes	Yes	Yes	Yes	

6.61.3 Co-existence studies

Table 6.61.3-1 lists Band 7 +Band n257 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.61.3-1: Band 7 and Band n257 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	2500	2570	26500	29500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	5000	5140	53000	59000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	7500	7710	79500	88500
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	23930	27000	29000	32070
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)	21360	24500	50430	56500
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)	31500	34640	55500	61570
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)	2100	2970	26480	29520
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)	22000	18790	76930	86000
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	54000	47860		
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)	34000	37210	82000	91070
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	58000	64160		
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)	115500	103430	16220	19500
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)	83500	74360	45290	51500
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)	108500	120570	36500	39780
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)	84500	93640	60500	66710

Based on Table 6.61.3-1;

- 3rd order IMD may fall into Rx frequencies of bands 1, 4, 7, 10, 23, 30, 34, 40, 41, 65, 66, 69, n257, n258 and n259.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.61.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.61.3-2: 2UL Band 7 +Band n257 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD3
	2400	-	2494	Yes	Asia	IMD3
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	

Table 6.61.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.61.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_7A-n257A	E-UTRA Band 1, 3, 5, 7, 8, 26, 28, 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	

6.61.4 ΔT_{IB} and ΔR_{IB} values

For DC_7A-n257A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.61.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_7A-n257A	7	0
	n257	0

Table 6.61.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_7A-n257A	7	0
	n257	0

6.61.5 MSD

No IMD problems are expected at both LTE band and NR band at FR2. Hence, not necessary for study on IMD problems for LTE-NR DC UE between sub6GHz and FR2. And up to 7th order harmonics are not impact to Rx frequency of both LTE and NR bands.

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6.62 DC_66_n257

6.62.1 Operating bands for DC

Table 6.62.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_66_n257	66	1710 MHz – 1780 MHz	2110 MHz – 2220 MHz	FDD
	n257	26.5 GHz – 29.5 GHz	26.5 GHz – 29.5 GHz	TDD

6.62.2 Channel bandwidths per operating band for DC

Table 6.62.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and 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]
DC_66A_n257A	66	15	Yes	Yes	Yes	Yes								420
	n257	60						Yes			Yes	Yes		
		120						Yes			Yes	Yes	Yes	
DC_66A_n257G	66	15	Yes	Yes	Yes	Yes								220
	n257	60	See CA_n257G CA bandwidth combination set 0 for Fallback group 3											
		120												
DC_66A_n257H	66	15	Yes	Yes	Yes	Yes								320
	n257	60	See CA_n257H CA bandwidth combination set 0 for Fallback group 3											
		120												
DC_66A_n257I	66	15	Yes	Yes	Yes	Yes								420
	n257	60	See CA_n257I CA bandwidth combination set 0 for Fallback group 3											
		120												
DC_66A_n257J	66	15	Yes	Yes	Yes	Yes								520
	n257	60	See CA_n257J CA bandwidth combination set 0 for Fallback group 3											
		120												
DC_66A_n257K	66	15	Yes	Yes	Yes	Yes								620
	n257	60	See CA_n257K CA bandwidth combination set 0 for Fallback group 3											
		120												
DC_66A_n257L	66	15	Yes	Yes	Yes	Yes								720
	n257	60	See CA_n257L CA bandwidth combination set 0 for Fallback group 3											
		120												
DC_66A_n257M	66	15	Yes	Yes	Yes	Yes								820
	n257	60	See CA_n257M CA bandwidth combination set 0 for Fallback group 3											
		120												

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Table 6.62.2-2: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band (non-contiguous)

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	**E-UTRA and 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]**
DC_66A_n257(2A)	66	15	Yes	Yes	Yes	Yes								420
	n257	60	See CA_n257(2A) CA bandwidth combinations in TS 38.101-2 [4].											
		120												820

6.62.3 Co-existence studies

Table 6.62.3-1 lists Band 66 +Band n257 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.62.3-1: Band 66 and Band n257 UL harmonics and IMD products

UE UL carriers	**fx_low**	**fx_high**	**fy_low**	**fy_high**
UL frequency (MHz)	1710	1780	26500	29500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3420	3560	53000	59000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5130	5340	79500	88500
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
	27790	24720	28210	31280
3rd order IMD products	|fy_high – 2*fx_low|	|fy_low – 2*fx_high|	|2*fy_low – fx_high|	|2*fy_high – fx_low|
	26080	22940	51220	57290
3rd order IMD products	|2*fx_low + fy_low|	|2*fx_high + fy_high|	|2*fy_low + fx_low|	|2*fy_high + fx_high|
	29920	33060	54710	60780
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|
	-55580	-49440	56420	62560
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|
	-24370	-21160	77720	86790
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|
	31630	34840	81210	90280
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|
	-116290	-104220	19380	22660
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|
	107710	119780	33340	36620
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|
	-85080	-75940	47660	53870
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|
	82920	92060	58130	64340

Based on Table 6.62.3-1;

- 2nd order harmonic may fall into Rx frequencies of bands 22, 42, 48, 49, 77 and 78.
- 3rd order harmonic may fall into Rx frequencies of band 46.

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- 2nd order IMD may fall into own Rx frequencies of band n257 (which can be disregarded, since no self-interference in TDD) as well as Rx frequencies of band n258.

- 3rd order IMD may fall into Rx frequencies of band n258.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.62.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.62.3-2: 2UL Band 66 +Band n257 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	

Table 6.62.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.62.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_66_n257	Band 2, 4, 5, 7, 10, 12, 13, 14, 17, 24, 25, 26, 27, 28, 29, 30, 38, 41, 43, 50, 51, 66, 70, 71, 74	F_{DL_low}	-	F_{DL_high}	-50	1	
	Band 42, 48	F_{DL_low}	-	F_{DL_high}	-50	1	1 (Note)
Note: Table 6.5.3.2-1 of TS38.101							

6.62.4 ΔT_{IB} and ΔR_{IB} values

For DC_66_n257, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.62.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_66_n257	66	0
	n257	0

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Table 6.62.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_66_n257	66	0
	n257	0

6.62.5 MSD

There is no MSD issue for this DC configuration.

6.63 DC_8A-n77A

6.63.1 Operating bands for DC

Table 6.63.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_8A-n77A	8	880 MHz – 915 MHz	925 MHz – 960 MHz	FDD
	n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	TDD

6.63.2 Channel bandwidths per operating band for DC

Table 6.63.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_8A-n77A	8	15	Yes	Yes	Yes	Yes						120
	n77	15		Yes	Yes	Yes	Yes	Yes				
		30		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
		60		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

6.63.3 Co-existence studies

Table 6.63.3-1 lists Band 8 +Band n77 2UL DC 2nd to 6th order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.63.3-1: Band 8 and Band n77 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	880	915	3300	4200
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1760	1830	6600	8400
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2640	2745	9900	12600
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	3520	3660	13200	16800
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	4400	4575	16500	21000
6th harmonics frequency limits	6*fx_low	6*fx_high	6* fy_low	6* fy_high
6th harmonics frequency limits (MHz)	5280	5490	19800	25200
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	2385	3320	4180	5115
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)	1470	2440	5685	7520
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)	5060	6030	7480	9315
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)	555	1560	8985	11720
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	6640	4770		
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)	5940	6945	10780	13515
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	8360	10230		
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)	15920	12285	680	360
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)	10840	8070	5760	3855
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)	14080	17715	6820	7860
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)	11660	14430	9240	11145

Based on Table 6.63.3-1;

- 22nd order harmonic may fall into Rx frequencies of bands 3,
- 3rd order harmonic may fall into Rx frequencies of bands 7 and 41,
- 4th order harmonic may fall into Rx frequencies of bands 22, 42, 43, 48, 49, n77 and n78,
- 5th order harmonic may fall into Rx frequencies of bands n79,
- 6th order harmonic may fall into Rx frequencies of bands 46 and n258,
- 2nd order IMD may also fall into Rx frequencies of band 7, 38, 40, 41, 69, n77, n78 and n79,
- 3rd order IMD may also fall into Rx frequencies of bands 1, 2, 3, 4, 9, 10, 11, 21, 22, 24, 25, 30, 32, 33, 34, 35, 36, 37, 39, 40, 46, 47, 50, 51, 65, 66, 70, 74 and 75,

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- 4th order IMD may also fall into Rx frequencies of bands 5, 6, 8, 11, 12, 13, 17, 18, 19, 20, 21, 24, 26, 27, 28, 29, 32, 44, 45, 46, 47, 50, 51, 67, 68, 71, 74, 75, 76 and n79,

- 5th order IMD may also fall into Rx frequencies of bands 31, 46, 71, 72, n77 and n79.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.63.3-2 lists if up to 6th order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.63.3-2: 2UL Band 8 +Band n77 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD3,4
Galileo	1559	-	1591	Yes		IMD3,4
GLONASS	1591	-	1610	Yes		IMD3
GPS	1563	-	1587	Yes		IMD3
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD2,3
	2400	-	2494	Yes	Asia	IMD2,3
ISM band (5GHz)	5150	-	5925	Yes	US	H6, IMD3,4,5
	5150	-	5350	Yes	Europe	H6, IMD3,4,5
	5470	-	5725	Yes		H6, IMD3,4,5
	5150	-	5825	Yes	Asia	H6, IMD3,4,5

Table 6.63.3-3 lists the protected bands required for the dual connectivity configuration.

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Table 6.63.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_8A-n77A	E-UTRA Band 1, 20, 28, 31, 32, 33, 34, 38, 39, 40, 44, 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	F_{DL_low}	-	F_{DL_high}	-50	1	2
	E-UTRA Band 8	F_{DL_low}	-	F_{DL_high}	-50	1	15
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	23
	Frequency range	860	-	890	-40	1	15, 23
	Frequency range	1884.5	-	1915.7	-41	0.3	8, 23
	NR Band n257	26500	-	29500	[-5]	100	

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

NOTE15: 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 23: 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 MHz ≤ F_c < 907.5 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 MHz ≤ F_c ≤ 912.5 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 MHz with an uplink transmission bandwidth less than or equal to 32 RB with RB_{start} > 3.

6.63.4 ΔT_{IB} and ΔR_{IB} values

For DC_8A-n77A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.63.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_8A-n77A	8	0.6
	n77	0.8

Table 6.63.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_8A-n77A	8	0.2
	n77	0.5

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6.63.5 MSD

Table 6.63.5-1 lists the MSD required for the dual connectivity configuration. As mentioned above, between Band 8 and n77, the 4th order harmonic of Band 8 Tx falls down to n77 Rx and IMD4 falls down to Band 8. (Note that IMDs falling down to n77 do not affect n77 Rx since n77 is TDD.) The results are as follows:

Table 6.63.5-1: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	40 MHz	50 MHz	60 MHZ	80 MHZ	100 MHZ
		dB	dB	dB	dB	dB	dB	dB	dB	dB
8	n77	NA	10.8	9.1	8.0	5.1	4.2	3.5	2.3	1.4

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 4th 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 $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.4 \rfloor 0.1$ in MHz and $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$ 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 6.63.5-2: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for EN-DC in NR FR1

UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz
8	n77		16	25	25			25	25	25	25	25

Table 6.63.5-3: MSD for the DC configuration

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_8A-n77A	8	897.5	5	25	942.5	8.3	FDD	IMD4
	n77	3635	10	52	3635	N/A	TDD	H4

6.63.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.63.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.63.6-1.

Table 6.63.6-1: Band 8 and Band n77 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_8A_n77A	8	a	-3	b	-1	4	8	IMD
	n77	c	1	d	0			
DC_8A_n77A	8	a	4	b	0	4	n77	Harmonic
	n77	c	0	d	-1			

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Equations (6.63.6.1) and (6.63.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.63.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.63.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.63.6.2)$$

Formula (3-1) and (3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.63.6.3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.63.6.3\text{-}2)$$

6.64 DC_8A-n257A

6.64.1 Operating bands for DC

Table 6.64.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band BS receive / UE transmit F_{UL_low} – F_{UL_high}	Downlink (DL) band BS transmit / UE receive F_{DL_low} – F_{DL_high}	Duplex mode
DC_8A-n257A	8	880 MHz – 915 MHz	925 MHz – 960 MHz	FDD
	n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD

6.64.2 Channel bandwidths per operating band for DC

Table 6.64.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	[50 MHz]	100 MHz	200 MHz	400 MHz	Maximum aggregated bandwidth [MHz]
DC_8A_n257A	8	15	Yes	Yes	Yes	Yes					420
	n257	60					Yes	Yes	Yes		
		120					Yes	Yes	Yes	Yes	

6.64.3 Co-existence studies

Table 6.64.3-1 lists Band 8 +Band n257 2UL DC 2nd to 6th order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.64.3-1: Band 8 and Band n257 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	880	915	26500	29500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1760	1830	53000	59000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2640	2745	79500	88500
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	3520	3660	106000	118000
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	4400	4575	132500	147500
6th harmonics frequency limits	6*fx_low	6*fx_high	6* fy_low	6* fy_high
6th harmonics frequency limits (MHz)	5280	5490	159000	177000
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	25585	28620	27380	30415
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)	24670	27740	52085	58120
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)	28260	31330	53880	59915
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)	23775	26860	78585	87620
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	51170	57240		
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)	29140	32245	80380	89415
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	54760	60830		
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)	105085	117120	22840	25980
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)	77670	86740	50255	56360
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)	106880	118915	30020	33160
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)	81260	90330	55640	61745

Based on Table 6.64.3-1;

- 2nd order harmonic may fall into Rx frequencies of bands 3,
- 3rd order harmonic may fall into Rx frequencies of bands 7 and 41,
- 4th order harmonic may fall into Rx frequencies of bands 22, 42, 43, 48, 49, n77 and n78,
- 5th order harmonic may fall into Rx frequencies of band n79,
- 6th order harmonic may fall into Rx frequencies of band 46,
- 2nd order IMD may also fall into Rx frequencies of bands n257 and n258,
- 3rd order IMD may also fall into Rx frequencies of bands n257 and n258,
- 4th order IMD may also fall into Rx frequencies of bands n257 and n258
- 5th order IMD may also fall into Rx frequencies of band n258.

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When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.64.3-2 lists if up to 6th order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.64.3-2: 2UL Band 8 +Band n257 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	Yes	US	H6
	5150	-	5350	Yes	Europe	H6
	5470	-	5725	Yes		H6
	5150	-	5825	Yes	Asia	H6

Table 6.64.3-3 lists the protected bands required for the dual connectivity configuration.

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Table 6.64.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_8A-n257A	E-UTRA Band 1, 28, 34, 38, 69, 74, n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA band 3, 7, 41, 42, 43	F_{DL_low}	-	F_{DL_high}	-50	1	2
	E-UTRA Band 8	F_{DL_low}	-	F_{DL_high}	-50	1	15
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	23
	Frequency range	860	-	890	-40	1	15, 23
	Frequency range	1884.5	-	1915.7	-41	0.3	8, 23

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

NOTE15: 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 23: 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 MHz ≤ F_c < 907.5 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 MHz ≤ F_c ≤ 912.5 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 MHz with an uplink transmission bandwidth less than or equal to 32 RB with RB_{start} > 3.

6.64.4 ΔT_{IB} and ΔR_{IB} values

For DC_8A-n257A, the $\Delta T_{IB,c}$ and ΔR_{IB} are proposed as follows, assuming separate RF chains are employed for these bands.

Table 6.64.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_8A-n257A	8	0
	n257	0

Table 6.64.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_8A-n257A	8	0
	n257	0

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6.64.5 MSD

As mentioned above, between Band 8 and n257, there is no harmonic relation and IMD2-4 fall down to Band n257. But these IMDs do not affect n257 Rx since n257 is TDD. Thus, there is no need to address MSD due to IMDs.

6.65 DC_25A_n41A

6.65.1 Operating bands for DC

Table 6.65.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC25A_n41A	25	1850 MHz – 1915 MHz	1930 MHz – 1995 MHz	FDD
	n41	2496 GHz – 2690 MHz	2496 GHz – 2690 MHz	TDD

6.65.2 Channel bandwidths per operating band for DC

Table 6.65.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz		Maximum aggregated bandwidth [MHz]
DC_25A_n41A	25	15	Yes	Yes	Yes	Yes								120
	n41	15		Yes	Yes	Yes		Yes	Yes					
		30		Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes		
		60		Yes	Yes	Yes		Yes	Yes	Yes	Yes	[Yes		

6.65.3 Co-existence studies

Table 6.65.3-1 lists Band 25 + Band n41 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.65.3-1: Band 25 and Band n41 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1850	1915	2496	2690
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3700	3830	4992	5380
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5550	5745	7488	8070
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	840	581	4346	4605
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)	1010	1334	3077	3530
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)	6196	6520	6842	7295
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)	1680	1162	8692	9210
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)	2860	3249	5573	6220
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)	8046	8435	9338	9985
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)	8910	8069	5164	4710
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)	11834	12675	9896	10350
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)	4370	3658	753	170
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)	11188	11900	10542	11125

Based on Table 6.65.3-1;

- 2nd order harmonic may fall into Rx frequencies of bands 43, 46, n77, n78 and n79
- 3rd order harmonic may fall into Rx frequencies of band 46
- 2nd order IMD may fall into Rx frequencies of bands 12, 13, 14, 17, 20, 28, 29, 44, 67, 68, 71 and n79.
- 3rd order IMD may fall into Rx frequencies of bands 22, 42, n77 and n78.
- 4th order IMD may fall into Rx frequencies of bands 11, 21, 24, 32, 45, 46, 47, 74, 75, 76,
- 5th order IMD may fall into Rx frequencies of bands 12, 13, 17, 29, 31, 43, 44, 46, 48, 67, 68, 71, 72, n77, n78, n79

When 2UL inter-band DC UE is operating with other systems such as Wi-Fi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.65.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.65.3-2: 2UL Band 25 +Band n41 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		IMD4
Galileo	1559	-	1591	No		IMD4
GLONASS	1591	-	1610	No		IMD4
GPS	1563	-	1587	No		IMD4
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	IMD3
	2400	-	2494	No	Asia	IMD3
ISM band (5GHz)	5150	-	5925	Yes	US	2nd Harmonic, 3rd Harmonic, IMD4, IMD5
	5150	-	5350	Yes	Europe	2nd harmonic, IMD5
	5470	-	5725	Yes		3rd harmonic, IMD4
	5150	-	5825	Yes	Asia	2nd harmonic, 3rd harmonic, IMD4, IMD5

Table 6.65.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.65.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_25A_n41A	NR band n5, n28, n66, n71 E-UTRA/NR Band 4, 10, 12, 13 , 14, 17, 24, 26, 27, 29, 30, 42, 45, 70	F_{DL_low}	-	F_{DL_high}	-50	1	
	NR band n2 E-UTRA/NR Band 2, 25	F_{DL_low}	-	F_{DL_high}	-50	1	1
	EUTRA/NR Band 43	F_{DL_low}	-	F_{DL_high}	-50	1	2
NOTE 1: 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. 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 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.						

6.65.4 ΔT_{IB} and ΔR_{IB} values

For DC_25A_n41A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

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Table 6.65.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_25A_n41A	25	0.5
	n41	0.5

Table 6.65.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_25A_n41A	25	0
	n41	0

6.65.5 MSD

The MSD due to cross band isolation is analysed based on assumptions in R4-1902111 and adopt shared antenna FE architecture (R4-1902457). MSD numbers are proposed in table 6.65.5-1.

Table 6.65.5-1: Reference sensitivity exceptions due to cross band isolation for EN-DC in NR FR1

		E-UTRA or NR Band / Channel bandwidth of the affected DL band												
UL band	DL band	SCS (kHz)	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)
n41	25		0.6	0.6	0.6	0.6								

Table 6.65.5-2: Uplink configuration for reference sensitivity exceptions due to cross band isolation for EN-DC in NR FR1

		E-UTRA or NR Band / Channel bandwidth of the affected DL band												
UL band	DL band	SCS (kHz)	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)
n41	25		160	160	160	160								

6.66 DC_26A_n41A

6.66.1 Operating bands for DC

Table 6.66.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_26A_n41A	26	814 MHz – 849 MHz	859 MHz – 894 MHz	FDD
	n41	2496 GHz – 2690 MHz	2496 GHz – 2690 MHz	TDD

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6.66.2 Channel bandwidths per operating band for DC

Table 6.66.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	**E-UTRA and NR Band**	**Subcarrier spacing [kHz]**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**25 MHz**	**40 MHz**	**50 MHz**	**60 MHz**	**80 MHz**	**100 MHz**		**Maximum aggregated bandwidth [MHz]**
DC_26A_n41A	26	15	Yes	Yes	Yes	Yes								120
	n41	15		Yes	Yes	Yes		Yes	Yes					
		30		Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes		
		60		Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes		

6.66.3 Co-existence studies

Table 6.66.3-1 lists Band 26 + Band n41 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.66.3-1: Band 26 and Band n41 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	814	849	2496	2690
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1628	1698	4992	5380
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2442	2547	7488	8070
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	1876	1647	3310	3539
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)	1062	798	4143	4566
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)	4124	4388	5806	6229
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)	3752	3294	6620	7078
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)	248	51	6639	7256
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)	4938	5237	8302	8919
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)	9946	9135	900	566
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)	10798	11609	5752	6086
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)	6442	5790	2445	2938
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)	9116	9768	7434	7927

Based on Table 6.66.3-1;

- 2nd order harmonics may fall into Rx frequencies of bands 46, n79
- 3rd order harmonics may fall into Rx frequencies of bands 41
- 2nd order IMD may fall into Rx frequencies of bands 3,9, 22, 35, 42, n77 and n78
- 3rd order IMD may fall into Rx frequencies of band 5, 6, 8, 18, 19, 20, 26, 27, 28, 44, 46, 47, n77 and n79
- 4th order IMD may fall into Rx frequencies of band 22, 42, 43, 46, n77, n78, n79
- 5th order IMD may fall into Rx frequencies of band 5, 6, 7, 12, 13, 14, 17, 18, 19, 20, 26, 27, 28, 29, 38, 41, 44, 46, 48, 67. 68, 69, 71

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There is a third order harmonic of the Band 26 uplink in n41. However, if the allocation for Band 26 is limited to the lowest 10 MHz of Band 26 (814-824/859-869 MHz) the harmonic no longer falls in n41. There is a third order IMD in the downlink frequencies of Band 26. However, if the Band 26 allocation is limited to the low 10 MHz of Band 26 (814-824/859-869 MHz) and the allocation for n41 is limited to the high 170 MHz of the band (2520 – 2690 MHz) the IM3 does not fall into the 10 MHz allocation for Band 26. There is also a 5th order IMD into n41, but since n41 is a TDD band, the UE wont't be transmitting and receiving on n41 simultaneously.

When 2UL inter-band DC UE is operating with other systems such as Wi-Fi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.66.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.66.3-3: Band 26 and Band n41 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	3rd harmonic, IMD5
	2400	-	2494	Yes	Asia	3rd harmonic, IMD5
ISM band (5GHz)	5150	-	5925	Yes	US	2nd harmonic, IMD3, IMD4, IMD5
	5150	-	5350	Yes	Europe	2nd harmonic, IMD4
	5470	-	5725	No		
	5150	-	5825	Yes	Asia	2nd harmonic, IMD3, IMD4, IMD5

Table 6.66.3-4 lists the protected bands required for the dual connectivity configuration.

Table 6.66.3-4: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_26A_n41A	E-UTRA/NR Band 1, 2, 3, 4, 5, 10, 12, 13 , 14, 17, 24, 25, 26, 28, 29, 30, 31, 34, 39, 40, 42, 43, 48, 50, 51, 65, 66, 70, 71, 74	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 9, 11, 18, 19, 21	F_{DL_low}	-	F_{DL_high}	-50	1	1
	Frequency range	1884.5		1915.7	-41	0.3	1,2
	Frequency range	703	-	799	-50	1	
	Frequency range	799	-	803	-40	1	3
	Frequency range	945	-	960	-50	1	
NOTE 1: This requirement applies when the NR carrier is confined within 2545-2575MHz or 2595-2645MHz and the channel bandwidth is 10 or 20 MHz NOTE 2: Applicable when co-existence with PHS system operating in 1884.5 -1915.7MHz NOTE 3: 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.							

6.66.4 ΔTIB and ΔRIB values

For DC_26A_n41A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

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Table 6.66.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_26A_n41A	26	TBD
	n41	TBD

Table 6.66.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_26A_n41A	26	TBD
	n41	0

6.66.5 MSD

Table 6.66.5-1 lists the MSD required for the dual connectivity configuration for the cases of IMD interference. Table 6.66.5-2 lists the harmonic interference which falls into the n41 RX frequency. Table 6.66.5-3 lists the case that n41 TX falls into the B26 3rd RX frequency.

Table 6.66.5-1: MSD for the DC configuration

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_26A_n41A	26	839	5	25	884	15.6	FDD	IMD3
	n41	2562	10	52	2562	N/A	TDD	N/A

Table 6.66.5-2 lists the MSD due to 3rd harmonic required for EN-DC configuration DC_26A_n41A.

Table 6.66.5-2: MSD due to 3rd harmonic for DC_26A_n41A

MSD due to harmonic for the DL band										
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz
		dB	dB	dB	dB	dB	dB	dB	dB	dB
26	n41	NA	10.3	8.4	7.4	5	4.3	3.9	3.1	2.7

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 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 $f_{DL}^{LB} = \lfloor f_{UL}^{HB} / 0.3 \rfloor 0.1$ in MHz and $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$ 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 6.66.5-3 lists the B26 UL configuration for n41 MSD test due to 3rd order harmonic interference.

Table 6.66.5-3: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference

UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz
26	n41	8	16	25	25	25	25	25	25	25	25

Table 6.66.5-4 lists the MSD values for DC_26A_n41A due to 3rd order harmonic mixing.

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Table 6.66.5-4: MSD due to 3rd order harmonic mixing for DC_26A_n41A

UL band	DL band	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
		dB	dB	dB	dB	dB	dB
n41	26	N/A	N/A	24.3	24.3	22.5	N/A
NOTE 1: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (higher) band for which the mixing product due to harmonic of victim (lower) band LO with leakage of aggressor (higher) band is within the downlink transmission bandwidth of a victim (lower) band.							
NOTE 2: The requirements should be verified for DL EARFCN of the victim (lower) band (superscript LB) such that $f_{DL}^{LB} = \lfloor f_{UL}^{HB} / 0.3 \rfloor 0.1$ in MHz and $F_{DL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{DL}^{LB} \le F_{DL\_high}^{LB} - BW_{Channel}^{LB} / 2$ with f_{DL}^{LB} carrier frequency in the victim (lower) band in MHz and $BW_{Channel}^{LB}$ the channel bandwidth configured in the lower band.							

Table 6.66.5-5 summarizes the n41 UL configuration for B26 3rd order harmonic mixing MSD test.

Table 6.66.5-5 n41 uplink configuration for B26 3rd order harmonic mixing MSD test

NR Band / Channel bandwidth of the high band / N_{RB}												
LTE-NR DC band combination	UL band	SCS	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz
DC_26_n41	n41	15	25	50	75							
NOTE 1: RB allocations in this table are corresponding to channel bandwidth of Band 26.												

6.66.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.66.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.66.6-1.

Table 6.66.6-1: Band 26 and Band n41 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_26A_n41A	26	a	-2	b	-1	3	26	IMD
	n41	c	1	d	0			
DC_26A_n41A	26	a	4	b	-1	5	26	IMD
	n41	c	-1	d	0			
DC_26A_n41A	26	a	3	b	0	3	n41	Harmonic
	n41	c	0	d	-1			
DC_26A_n41A	26	a	0	b	3	3	26	Harmonic mixing
	n41	c	-1	d	0			

Equations (6.66.6.1) and (6.66.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.66.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.66.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.66.6.2)$$

Formula (6.66.6.3-1) and (6.66.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

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$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.66.6.3\text{-}1)$$

$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.66.6.3\text{-}2)$$

6.67 DC_41A_n41A, DC_(n)41AA

6.67.1 Operating bands for DC

Table 6.67.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_41A_n41A, DC_(n)41AA	41	2496 GHz – 2690 MHz	2496 GHz – 2690 MHz	TDD
	n41	2496 GHz – 2690 MHz	2496 GHz – 2690 MHz	TDD

6.67.2 Channel bandwidths per operating band for DC

Table 6.67.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz		Maximum aggregated bandwidth [MHz]
DC_41A_n41A	41	15	Yes	Yes	Yes	Yes								120
	n41	15		Yes	Yes	Yes		Yes	Yes					
		30		Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes		
		60		Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes		

6.67.3 Co-existence studies

Table 6.67.3-1 lists Band 41 + Band n41 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.67.3-1: Band 41 and Band n41 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	2496	2690	2496	2690
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	4992	5380	4992	5380
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	7488	8070	7488	8070
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	194	194	4992	5380
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)	2302	2884	2302	2884
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)	7488	8070	7488	8070
3rd order IMD products (max BW)	|fx_low – max BW fy|	|fx_high + max BW fy|	|fy_low – max BW fx|	|fy_high + max BW fx|
IMD frequency limits (MHz)	2396	2790	2476	2710
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)	388	388	9984	10760
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)	4798	5574	4798	5574
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)	9984	10760	9984	10760
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)	8264	7294	8264	7294
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)	12480	13450	12480	13450
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)	3078	2108	3078	2108
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)	12480	13450	12480	13450

Based on Table 6.67.3-1;

- 2nd order harmonics may fall into Rx frequencies of bands 46 and n79
- 2nd order IMD may fall into Rx frequencies of bands 46 and n79
- 3rd order IMD may fall into Rx frequencies of band 7, 30, 38, 40. 41 and 69
- 4th order IMD may fall into Rx frequencies of band 46 and 79
- 5th order IMD may fall into Rx frequencies of band 1, 4, 7, 10, 23, 30, 38, 40, 41, 65. 66 and 69

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When 2UL inter-band DC UE is operating with other systems such as Wi-Fi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.67.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.67.3-2: 2UL Band 41 +Band n41 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	Yes[NOTE]	US/Europe	IMD3
	2400	-	2494	Yes[NOTE]	Asia	IMD3
ISM band (5GHz)	5150	-	5925	Yes	US	2nd Harmonic, IMD2, IMD4
	5150	-	5350	Yes	Europe	2nd Harmonic, IMD2, IMD4
	5470	-	5725	No		IMD4
	5150	-	5825	Yes	Asia	2nd Harmonic, IMD2, IMD4
NOTE: depends on the B41 and n41 allocation						

Table 6.67.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.67.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_41A_n41A, DC_(n)41AA	E-UTRA/NR Band 1, 2, 3, 4, 5, 8, 10, 12, 13 , 14, 17, 24, 25, 26, 27, 28, 29, 30, 34, 39, 40, 42, 44, 45, 48, 50, 51, 65, 66, 70, 71, 74	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 9, 11, 18, 19, 21	F_{DL_low}	-	F_{DL_high}	-50	1	1
	Frequency range	1884.5	-	1915.7	-41	0.3	1,2
NOTE 1: This requirement applies when the E-UTRA carrier is confined within 2545-2575 MHz or 2595-2645 MHz and the channel bandwidth is 10 or 20 MHz NOTE 2: Applicable when co-existence with PHS system operating in 1884.5 -1915.7MHz.							

6.67.4 ΔT_{IB} and ΔR_{IB} values

For DC_41A_n41A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.67.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_41A_n41A	41	0
	n41	0

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Table 6.67.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_41A_n41A	41	0
	n41	0

6.67.5 MSD

Since Band 41 and n41 are both TDD bands, no MSD is required for the dual connectivity configuration.

6.67.6 SEM for DC_41A_n41A

The spectral emission mask for DC_41A_n41 is a composite of the emission mask for each CC with the level set to the maximum value from each mask for each frequency outside of the transmission bandwidth of either carrier. A composite spectrum emission mask is a combination of individual CC spectrum emissions masks. Where two masks overlap the most relaxed limit is used. When NS_04 is signalled the emissions must also meet the additional requirements. Also, when NS_04 is signalled, the general spurious emission mask is -25 dBm/MHz, not -30 dBm/MHz..

6.67.6a SEM for DC_(n)41AA

The SEM for DC_(n)41AA will be based on the aggregated emisission bandwidth. The aggregated emission bandwidth determines the frequency where the emission mask drops from -13 dBm/MHz to -25 dBm/MHz. When NS_04 is signalled the emissions must also meet the additional requirements. Also, when NS_04 is signalled, the general spurious emission mask is -25 dBm/MHz, not -30 dBm/MHz.

Table 6.67.6a-1: DC_(n)41AA spectrum emission mask

Δf_{OOB} (MHz)	**Minimum requirement [dBm]**	**Measurement bandwidth**
0 MHz ≤ Δf < 1 MHz	See Table 6.67.6a-2	30kHz
1 MHz ≤ Δf < 5 MHz	-10	1 MHz
5 MHz ≤ Δf < ENBW	-13	1 MHz
ENBW ≤ Δf < ENBW + 5 MHz	-25	1 MHz
NOTE 1: ENBW is the aggregated bandwidth of an E-UTRA sub-block and an adjacent NR sub-block; there is no frequency separation between the said sub-blocks. The sub-block bandwidths include any internal guard bands.		

Table 6.67.6a-2: DC_(n)41AA Requirement for 1st MHz

ENBW	**10MHz**	**15MHz**	**20MHz**	**40MHz**	**50MHz**	**>50MHz**
1st 1MHz Requirement	-18	-20	-21	-24	-25	-25

6.67.7 A-MPR

Band 41 and n41 will need to meet the emission mask for ns_04. The requirements are TBD.

6.67.8 Bandwidth Combination Sets

At RAN4 #86 bis it was agreed to allow Bandwidth Combination Sets for intra-band EN-DC in R4-1804220.

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Table 6.67.8-1: Bandwidth Combination Sets for DC_(n)41AA and DC_41A_n41A

Downlink EN-DC configuration	Uplink EN-DC configurations	E-UTRA – NR configuration / Bandwidth combination set				
		Component carriers in order of increasing carrier frequency			Maximum aggregated bandwidth [MHz]	Bandwidth combination set
		Channel bandwidths for LTE carrier [MHz]	Channel bandwidths NR for carrier [MHz]	Channel bandwidths for LTE carrier [MHz]		
DC_(n)41AA	DC_(n)41AA	20	40, 60, 80,100		120	0
			40, 60, 80,100	20		
DC_41A_n41A	DC_41A_n41A	20	40, 60, 80,100		120	0
			40, 60, 80,100	20		

6.68 DC_66A_n71A

6.68.1 Operating bands for DC

Table 6.68.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_66A_n71A	66	1710 MHz – 1780 MHz	2110 MHz – 2200 MHz	FDD
	n71	663 MHz – 698 MHz	617 MHz – 652 MHz	FDD

6.68.2 Channel bandwidths per operating band for DC

Table 6.68.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	50 MHz	80 MHz	100 MHz	400 MHz	Maximum aggregated bandwidth [MHz]
DC_66A_n71A	66	15	Yes	Yes	Yes	Yes						40
	n71	15	Yes	Yes	Yes	Yes						
		30	Yes	Yes	Yes	Yes						

6.68.3 Co-existence studies

Table 6.68.3-1 lists Band 66 +Band n71 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.68.3-1: Band 66 and Band n71 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	663	698	1710	1780
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1326	1396	3420	3560
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	1989	2094	5130	5340
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
	1117	1012	2373	2478
Two-tone 3rd order IMD products	|fy_high – 2*fx_low|	|fy_low – 2*fx_high|	|2*fy_low – fx_high|	|2*fy_high – fx_low|
	454	314	2722	2897
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|
	3036	3176	4083	4258
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|
	2234	2024	4746	4956
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|
	209	384	4432	4677
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|
	3699	3874	5793	6038
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|
	6457	6142	1082	872
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|
	7503	7818	4362	4572
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|
	4014	3734	1326	1571
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|
	6456	6736	5409	5654

Based on Table 6.68.3-1;

- 2nd order harmonic may fall into Rx frequencies of bands 22, 42, 48, 77 and 78.
- 3rd order harmonic may fall into Rx frequencies of bands 2, 25, 34, 36, 46 and 70.
- 2nd order IMD may fall into Rx frequencies of band 30 and 40.
- 3rd order IMD may fall into Rx frequencies of band 77.
- 4th order IMD may fall into own Rx frequencies of band 66 as well as Rx frequencies of band 1, 4, 10, 23, 34, 43, 47, 48, 65, 77, 79 and 79.
- 5th order IMD may fall into Rx frequencies of band 5, 6, 8, 11, 18, 19, 21, 24, 26, 32, 43, 45, 46, 50, 74, 75, 76, 77, 78 and 79.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.68.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.68.3-2: 2UL Band 66 +Band n71 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD5
Galileo	1559	-	1591	Yes		IMD5
GLONASS	1591	-	1610	Yes		IMD5
GPS	1563	-	1587	Yes		IMD5
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	Yes	US	IMD4, IMD5
	5150	-	5350	No	Europe	
	5470	-	5725	Yes		IMD5
	5150	-	5825	Yes	Asia	IMD4, IMD5

Table 6.68.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.68.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_66A_n71A	E-UTRA Band 4, 5, 7,10, 13, 14, 17, 22, 24, 26, 27, 29, 30, 43,-50, 51, 66, 74	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 2, 25, 41, 42, 48, 70	F_{DL_low}	-	F_{DL_high}	-50	1	2
	E-UTRA Band 71	F_{DL_low}	-	F_{DL_high}	-50	1	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 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: 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.							

6.68.4 ΔT_{IB} and ΔR_{IB} values

For DC_66A_n71A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.68.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_66A_n71A	66	0.3
	n71	0.3

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Table 6.68.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_66A_n71A	66	0
	n71	0

6.68.5 MSD

A combination of Band 66 and band 71 have similarities to CA_1A-8A and CA_3A-5A. Both these are a low band plus a high band, and both have IMD4 affecting the high band. CA_3A-5A has 4 dB and CA_1A-8A has 6 dB as MSD, and for a combination of band 66 and band 71 the MSD is set to an average value of 5 dB.

Table 6.68.5-1 lists the MSD required for the dual connectivity configuration DC_66A_n71A.

Table 6.68.5-1: MSD for the DC_66A_n71A configuration

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_66A_n71A	66	1750	5	25	2150	5	FDD	IMD4
	n71	675	5	25	629	N/A		N/A

6.68.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.68.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.68.6-1.

Table 6.68.6-1: Band 66 and Band n71 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_66A_n71A	66	a	2	b	-1	4	66	IMD
	n71	c	-2	d	0			

Equations (6.68.6.1) and (6.68.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.68.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.68.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.68.6.2)$$

Formula (6.68.6.3-1) and (6.68.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.68.6.3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.68.6.3\text{-}2)$$

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6.69 DC_(n)71B

6.69.1 Operating bands for DC

Table 6.69.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band	Downlink (DL) band	Duplex mode
		BS receive / UE transmit	BS transmit / UE receive	
		$F_{UL\_low} – F_{UL\_high}$	$F_{DL\_low} – F_{DL\_high}$	
DC_(n)71B	71	663 MHz – 698 MHz	617 MHz – 652 MHz	FDD
	n71			

6.69.2 Channel bandwidths per operating band for DC

Table 6.69.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

EN-DC configuration / Bandwidth combination set					
Downlink EN-DC configuration	Uplink EN-DC configuration	Component carriers in order of increasing carrier frequency		Maximum aggregated bandwidth [MHz]	Bandwidth combination set
		Channel bandwidths for LTE carrier [MHz]	Channel bandwidths for NR carrier [MHz]		
DC_(n)71B	DC_(n)71B	15	5	20	0
		10	5, 10		
		5	5, 10, 15		

6.69.3 Co-existence studies

DC_(n)71B is a contiguous allocation thus only uplink harmonic analysis is needed.

Table 6.69.3-1: DC_(n)71B UL harmonics

Uplink band			2nd Harmonic		3rd 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
71	663	698	1326	1396	1989	2094

From Table 6.69.3-1 it can be seen that uplink harmonics 3rd harmonic overlaps with bands 3, 25, 34 and 70.

6.69.4 ΔT_{IB} and ΔR_{IB} values

No dTib or dRib is required for DC_(n)71B as it is intraband DC.

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6.69.5 MSD

Table 6.69.5-1: MSD for the DC_(n)71B configuration

MSD / DC bandwidth class B							
DC configuration	**E-UTRA/NR band**	**F_C (UL) (MHz)**	**Channel bandwidth (MHz)**	**UL allocation [LCRB]**	**F_C (DL) (MHz)**	**MSD (dB)**	**Duplex mode**
DC_(n)71B	71	665.5	5	5 (RB_{end} =24)	619.5	0	FDD
	n71	675.5	15	15 (RB_{start} = 0)	629.5	1.8	
	71	670.5	15	15 (RB_{end} = 74)	624.5	0	
	n71	680.5	5	5 (RB_{start} = 0)	634.5	1.6	
	71	668	10	10 (RB_{end} = 49)	622	0	
	n71	678	10	10 (RB_{start} = 0)	632	1.7	
	71	668	10	10 (RB_{start} = 0)	622	[24.3]	
	n71	678	10	10 (RB_{end} = 51)	632	[35.2]	

6.69.6 SEM for DC_(n)71B

FCC has defined spectrum emission maks that is relevant for operation on band 71 frequency range. SEM is presented in Table 6.69.6-1.

6.69.6-1: SEM for band 71 frequency range

Δf_{OOB} (MHz)	**Frequency offset of measurement filter centre frequency, f_offset**	**Minimum requirement [dBm]**	**Measurement bandwidth**
0 MHz ≤ Δf < 0.1 MHz	0.015 MHz ≤ f_offset < 0.085 MHz	-13	30 kHz
0.1 MHz ≤ Δf < ENBW	0.15 MHz ≤ f_offset < ENBW – 0.05 MHz	-13	100 kHz
ENBW ≤ Δf < ENBW + 5 MHz	ENBW+0.5 MHz ≤ f_offset < ENBW + 4.5 MHz	-25	1 MHz
NOTE 1: ENBW is the aggregated bandwidth of an E-UTRA sub-block and an adjacent NR sub-block; there is no frequency separation between the said sub-blocks. The sub-block bandwidths include any internal guard bands.			

6.69.7 A-MPR

Figure 6.69.7-1 shows required back-off as function of allocation ratio. Figure contains data for all included bandwidth combinations, SCSs in the worst-case position (upper band edge). From this data we have derived a unified A-MPR definition for the whole band n71.

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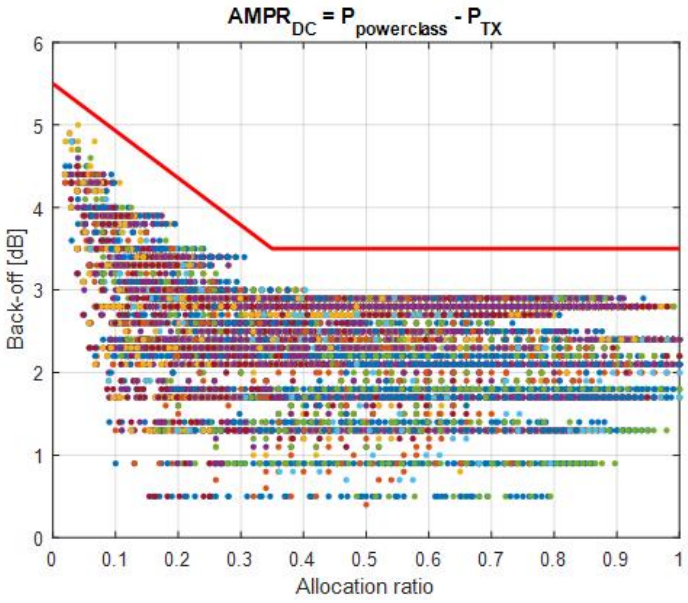


Figure 6.69.7-1: Back-off vs. allocation ratio for entire band n71 (all bandwidth combinations and SCSs)

When LTE and NR know each other's allocation, the A-MPR(1) is defined in terms of the total transmission powers as

$$AMPR_{DC} = P_{powerclass} - P_{TX} = CEIL\{M_{A,DC}(A), 0.5\}$$

where

$$M_{A,DC}(A) = \begin{cases} 5.50 - 5.71\ A; & 0.00 < A <= 0.35 \\ 3.50; & 0.35 < A <= 1.00 \end{cases}$$

The allocation ratio is

$$A = \frac{L_{CRB,LTE} + L_{CRB,NR}}{N_{RB,LTE} + N_{RB,NR}}$$

When LTE and NR do not know each other's allocation, The A-MPR(2) is defined carrier wise as

$$AMPR_{LTE} = P_{powerclass} - P_{LTE} = CEIL\{M_{A,LTE}, 0.5\}$$

$$AMPR_{NR} = P_{powerclass} - P_{NR} = CEIL\{M_{A,NR}, 0.5\}$$

where

$$M_{A,LTE} = M_{A,DC}(A_{LTE,wc}) - \Delta_{LTE}$$

$$M_{A,NR} = M_{A,DC}(A_{NR,wc}) - \Delta_{NR}$$

Above, the worst-case allocation ratios for each carrier are as follows where LTE modems assumes that NR allocation is 1 as it will lead to maximum needed A-MPR and vice versa.

$$A_{LTE,wc} = \frac{L_{CRB,LTE} + 1}{N_{RB,LTE} + N_{RB,NR}}$$

$$A_{NR,wc} = \frac{1 + L_{CRB,NR}}{N_{RB,LTE} + N_{RB,NR}}$$

and the worst-case division of power between carriers is represented by

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$$\Delta_{LTE} = 10 \ log_{10} \frac{L_{CRB,LTE}}{L_{CRB,LTE} + \tilde{N}_{RB,NR}}$$

and

$$\Delta_{NR} = 10 \ log_{10} \frac{L_{CRB,NR}}{N_{RB,LTE} + L_{CRB,NR}}$$

Table 6.69.7-1. Symbols for DC_(n)71B A-MPR

P_{TX}	Total transmission power (LTE+NR)
P_{LTE}	Transmission power of the LTE channel
P_{NR}	Transmission power of the NR channel
$L_{CRB,LTE}$	Allocation size (in RB) in LTE channel
$L_{CRB,NR}$	Allocation size (in RB) in NR channel
$N_{RB,LTE}$	Transmission bandwidth configuration in LTE channel
$N_{RB,NR}$	Transmission bandwidth configuration in NR channel for its configured SCS
$\tilde{N}_{RB,NR}$	Transmission bandwidth configuration in NR channel for the SCS assumed by the LTE branch (minimum SCS valid for the NR channel bandwidth)

6.70 DC_20A-n8A

6.70.1 Operating bands for DC

Table 6.70.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band		Downlink (DL) band		Duplex mode
		BS receive / UE transmit	Channel BW (MHz)	BS transmit / UE receive	Channel BW (MHz)	
		F_{UL_low} – F_{UL_high}		F_{DL_low} – F_{DL_high}		
DC_20A-n8A	20	832 MHz – 862 MHz		791 MHz – 821 MHz		FDD
	n8	880 MHz – 915 MHz		925 MHz – 960 MHz		

6.70.2 Channel bandwidths per operating band for DC

Table 6.70.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

	DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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
DC_20A-n8A	20	15	Yes	Yes								30	0
	n8	15	Yes	Yes	Yes	Yes							
		30		Yes	Yes	Yes							
		60											

6.70.3 Co-existence studies

Tables 6.70.3-1, Band 20A+Band n8A 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.70.3-1: Band 20 and Band n8 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fn_low	fn_high
UL frequency (MHz)	832	862	880	915
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fn_low	2* fn_high
2nd harmonics frequency limits (MHz)	1664 – 1724		1760 – 1830	
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fn_low	3* fn_high
3rd harmonics frequency limits (MHz)	2496 – 2586		2640 – 2745	
2nd order IMD products	|fn_low – fx_high|	|fn_high – fx_low|	|fn_low + fx_low|	|fn_high + fx_high|
IMD frequency limits (MHz)	18 – 83		1712 – 1777	
Two-tone 3rd order IMD products	|2*fx_low – fn_high|	|2*fx_high – fn_low|	|2*fn_low – fx_high|	|2*fn_high – fx_low|
IMD frequency limits (MHz)	749 – 844		898 – 998	
Two-tone 3rd order IMD products	|2*fx_low + fn_low|	|2*fx_high + fn_high|	|2*fn_low + fx_low|	|2*fn_high + fx_high|
IMD frequency limits (MHz)	2544 – 2639		2592 – 2692	
Two-tone 3rd order IMD products	(fx_low – max BW fn)	(fx_high + max BW fn)	(fn_low – max BW fx)	(fn_high + max BW fx)
IMD frequency limits (MHz)	812 – 882		870 – 925	
Two-tone 4th order IMD products	|3*fx_low –1* fn_high|	|3*fx_high – 1*fn_low|	|3*fn_low – 1*fx_high|	|3*fn_high – 1*fx_low|
IMD frequency limits (MHz)	1581 – 1706		1778 – 1913	
Two-tone 4th order IMD products	|2*fx_low –2* fn_high|	|2*fx_high –2* fn_low|		
IMD frequency limits (MHz)	36 – 166			
Two-tone 4th order IMD products	|3*fx_low +1* fn_low|	|3*fx_high + 1*fn_high|	|3*fn_low + 1*fx_low|	|3*fn_high + 1*fx_high|
IMD frequency limits (MHz)	3376 – 3501		3472 – 3607	
Two-tone 4th order IMD products	|2*fx_low +2* fn_low|	|2*fx_high +2* fn_high|		
IMD frequency limits (MHz)	3424 – 3554			
Two-tone 5th order IMD products	|fx_low – 4*fn_high|	|fx_high – 4*fn_low|	|fn_low – 4*fx_high|	|fn_high – 4*fx_low|
IMD frequency limits (MHz)	2658 –2828		2413 – 2568	
Two-tone 5th order IMD products	|2*fx_low - 3*fn_high|	|2*fx_high - 3*fn_low|	|2*fn_low - 3*fx_high|	|2*fn_high - 3*fx_low|
IMD frequency limits (MHz)	916 – 1081		666 – 826	
Two-tone 5th order IMD products	|fx_low + 4*fn_low|	|fx_high + 4*fn_high|	|fn_low + 4*fx_low|	|fn_high + 4*fx_high|
IMD frequency limits (MHz)	4352 – 4522		4208 – 4363	
Two-tone 5th order IMD products	|2*fx_low + 3*fn_low|	|2*fx_high + 3*fn_high|	|2*fn_low + 3*fx_low|	|2*fn_high + 3*fx_high|
IMD frequency limits (MHz)	4304 – 4469		4256 – 4416	

Based on Table 6.70.3-1,

- 2nd order harmonics may fall into Rx frequencies of Band 3
- 3rd order harmonics may fall into Rx frequencies of Band 7, 38, 41, 69
- 3rd order IMD may fall into Rx frequencies of Band 5, 6, 7, 8, 13, 14, 18, 19, 20, 26, 27, 28, 38, 41, 44, 67, 68, and 69
- 4th order IMD may fall into Rx frequencies of Band 3, 9, 22, 33, 35, 37, 39, 42, 43, 48, n77, and n78
- 5th order IMD may fall into Rx frequencies of Band 7, 8, 12, 13, 14, 17, 20, 28, 29, 41, 44, 67, and 68

When 2UL inter-band DC UE is operating with other systems such as Wi-Fi, Bluetooth and GNSS; the harmonics and intermodulation products can have impact on these systems. Table 6.70.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.70.3-2: 2UL Band 20 + Band n8 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD4
Galileo	1559	-	1591	Yes		IMD4
GLONASS	1591	-	1610	Yes		IMD4
GPS	1563	-	1587	Yes		IMD4
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD5
	2400	-	2494	Yes	Asia	IMD5
ISM band (5GHz)	5150	-	5925	No	US	-
	5150	-	5350	No	Europe	-
	5470	-	5725	No		-
	5150	-	5825	No	Asia	-

Table 6.70.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.70.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_20A-n8A	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	

6.70.4 ΔT_{IB} and ΔR_{IB} values

For DC_20A-n8A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.70.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_20A-n28A	20	0.4
	n8	0.4

Table 6.70.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_20A-n28A	20	0
	n8	0

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6.70.5 MSD

Table 6.70.5-1: MSD for the DC configuration

EN-DC Configuration	EUTRA or NR band	UL F_c (MHz)	UL/DL BW (MHz)	UL L_{CRB}	DL F_c (MHz)	MSD (dB)	Duplex mode	IMD order	Single UL allowed
DC_20A-n8A	20	849.5	5	25	808.5	21	FDD	IMD3	Yes
	n8	892.5	5	25	937.5	21	FDD	IMD3	

6.70.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.70.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.70.6-1.

Table 6.70.6-1: Band 20 and Band n8 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_20A_n8A	20	a	2	b	-1	3	20	IMD
	n8	c	-1	d	0			
DC_20A_n8A	20	a	3	b	-1	5	20	IMD
	n8	c	-2	d	0			
DC_20A_n8A	20	a	-2	b	0	5	n8	IMD
	n8	c	3	d	-1			

Equations (6.70.6.1) and (6.70.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.70.6-1 and CBW stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.70.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.70.6.2)$$

Formula (6.70.6.3-1) and (6.70.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.70.6.3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.70.6.3\text{-}2)$$

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6.71 DC_46A_n78A

6.71.1 Operating bands for DC

Table 6.71.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band BS receive / UE transmit F_{UL_low} – F_{UL_high}	Downlink (DL) band BS transmit / UE receive F_{DL_low} – F_{DL_high}	Duplex mode
DC_46A_n78A	46	5150 MHz – 5925 MHz	5150 MHz – 5925 MHz	TDD
	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	

6.71.2 Channel bandwidths per operating band for DC

Table 6.71.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Maximum aggregated bandwidth [MHz]
DC_46A_n78A[1]	46	15		Yes		Yes								120
	n78	15		Yes		Yes			Yes	Yes				
		30		Yes		Yes			Yes	Yes	Yes	Yes	Yes	
		60		Yes		Yes			Yes	Yes	Yes	Yes	Yes	
NOTE 1: Restricted to E-UTRA operation when inter-band carrier aggregation is configured. The downlink operating band for Band 46 is paired with the uplink operating band (external E-UTRA band) of the carrier aggregation configuration that is supporting the configured Pcell.														

6.71.3 Co-existence studies

N/A

6.71.4 ΔTIB and ΔRIB values

For DC_46A-n78A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.71.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_46A-n78A	n78	0.8

Table 6.71.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_46A-n78A	n78	0.5

6.71.5 MSD

DC_46A_n78A is subjected to MSD due to cross band isolation referring same mechanism of LTE CA_46A-48A result. The MSD due to cross band isolation is calculated as below tables:

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Table 6.71.5-1: Reference sensitivity exceptions (MSD) due to cross band isolation for EN-DC in NR FR1

	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)
n78	46				7								

Table 6.71.5-2: Uplink configuration for reference sensitivity exceptions due to cross band isolation for EN-DC in NR FR1

	E-UTRA or NR Band / SCS / Channel bandwidth of the affected DL band / UL RB allocation of the agressor band													
UL band	DL band	SCS of UL band (kHz)	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})	80 MHz (L_{CRB})	90 MHz (L_{CRB})	100 MHz (L_{CRB})
n78	46	30				270								

6.72 DC_1A-n50A

6.72.1 Operating bands for DC

Table 6.72.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_1A-n50A	1	1920 MHz – 1980 MHz	2110 MHz – 2170 MHz	FDD
	n50	1432 MHz – 1517 MHz	1432 MHz – 1517 MHz	TDD

6.72.2 Channel bandwidths per operating band for DC

Table 6.72.2-1

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Maximum aggregated bandwidth [MHz]
DC_1A-n50A	1	15	Yes	Yes	Yes	Yes								100
	n50	15	Yes	Yes	Yes	Yes			Yes	Yes				
		30		Yes	Yes	Yes			Yes	Yes	Yes	Yes[3]		
		60		Yes	Yes	Yes			Yes	Yes	Yes	Yes[3]		
NOTE 3: This UE channel bandwidth is applicable only to downlink.														

6.72.3 Co-existence studies

Table 6.72.3-1 lists Band 1 + Band n50 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.72.3-1: Band 1 and Band n50 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	**1432**	**1517**	**1920**	**1980**
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	2864	3034	3840	3960
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	4296	4551	5760	5940
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)	403	548	3352	3497
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)	884	1114	2323	2528
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)	4784	5014	5272	5477
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)	1412	1537	1860	2040
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)	2316	2631	4243	4508
Two-tone 4th order IMD products	(2*fy_low – 2*fx_high)	(2*fy_high – 2*fx_low)		
IMD frequency limits (MHz)	806	1096		
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)	6216	6531	7192	7457
Two-tone 4th order IMD products	(2*fx_low + 2*fy_low)	(2*fx_high + 2*fy_high)		
IMD frequency limits (MHz)	6704	6994		
Two-tone 5th 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)	6163	6488	3748	4148
Two-tone 5th 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)	2726	3076	711	336
Two-tone 5th 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)	9112	9437	7648	8048
Two-tone 5th 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)	8624	8974	8136	8511

Based on Table 6.72.3-1

- 2rd order harmonic may fall into Rx frequencies of band n77.
- 3rd order harmonic may fall into Rx frequencies of band 46, n79.

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- 2nd order IMD may fall into Rx frequencies of bands 31, 42, 72, n77 and n78.
- 3rd order IMD may fall into Rx frequencies of bands 3, 5, 6, 8, 9, 19, 24, 26, 30, 33, 34, 35, 39, 40, 41, 46, 51, 70 and n79
- 4th order IMD may fall into Rx frequencies of bands 5, 6, 7, 8, 18, 19, 20, 26, 27, 30, 38, 40, 41, 69, and n79
- 5th order IMD may fall into Rx frequencies of bands 43, 44, n77 and n78

It should be noted that IMD will not be an issue for band n50 (no self-interference for the TDD band) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.72.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.72.3-2: 2UL Band 1 +Band n50 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD3
Galileo	1559	-	1591	Yes		IMD3
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	Yes		IMD3
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD3, 4
	2400	-	2494	Yes	Asia	IMD3, 4
ISM band (5GHz)	5150	-	5925	Yes	US	Harmonic3, IMD3
	5150	-	5350	Yes	Europe	IMD3
	5470	-	5725	Yes		IMD3
	5150	-	5825	Yes	Asia	Harmonic3, IMD3

Table 6.72.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.72.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission				
	Protected band	Frequency range (MHz)	Maximum Level (dBm)	MBW (MHz)	NOTE

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DC_1A-n50A	E-UTRA Band 22, 28, 43, 67, 68, 69, 73	F_{DL_low} FDL_low	- - -	F_{DL_high} FDL_high	-50	1	
	E-UTRA Band 3, 34	F_{DL_low}	-	F_{DL_high}	-50	1	15, 2
	Frequency range	1880	-	1895	-40	1	15, 27
	Frequency range	1895	-	1915	-15.5	5	15, 26, 27
	Frequency range	1915	-	1920	+1.6	5	15, 26, 27
	E-UTRA Band 5, 6, 7, 8, 20, 26, 27, 30, 31, 38, 40, 41, 42, 44, 46, 72 NR Band n77, n78, n79,	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 6.6.3.1-2 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 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 15: 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.

NOTE 26: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.

NOTE 27: 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.

6.72.4 ΔTIB and ΔRIB values

For DC_1A-n50A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.72.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_1A-n50A	1	0.6
	n50	0.6

Table 6.72.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_1A-n50A	n50	0.2

6.72.5 MSD

There is no specific MSD's requirement.

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6.73 DC_1A-n51A

6.73.1 Operating bands for DC

Table 6.73.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_1A-n51A	1	1920 MHz – 1980 MHz	2110 MHz – 2170 MHz	FDD
	n51	1427 MHz – 1432 MHz	1427 MHz – 1432 MHz	TDD

6.73.2 Channel bandwidths per operating band for DC

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Maximum aggregated bandwidth [MHz]
DC_1A-n51A	1	15	Yes	Yes	Yes	Yes								25
	n51	15	Yes											
		30												
		60												

6.73.3 Co-existence studies

Table 6.73.3-1 lists Band 1 + Band n51 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.73.3-1: Band 1 and Band n51 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1427	1432	1920	1980
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	2854	2864	3840	3960
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	4281	4296	5760	5940
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)	488	553	3347	3412
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)	874	944	2408	2533
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)	4774	4844	5267	5392
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)	1407	1452	1915	1985
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)	2301	2376	4328	4513
Two-tone 4th order IMD products	(2*fy_low – 2*fx_high)	(2*fy_high – 2*fx_low)		
IMD frequency limits (MHz)	976	1106		
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)	6201	6276	7187	7372
Two-tone 4th order IMD products	(2*fx_low + 2*fy_low)	(2*fx_high + 2*fy_high)		
IMD frequency limits (MHz)	6694	6824		
Two-tone 5th 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)	6248	6493	3728	3808
Two-tone 5th 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)	2896	3086	456	321
Two-tone 5th 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)	9107	9352	7628	7708
Two-tone 5th 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)	8614	8804	8121	8256

Based on Table 6.73.3-1

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- 2rd order harmonic may fall into Rx frequencies of band n77.
- 3rd order harmonic may fall into Rx frequencies of band 46.
- 2nd order IMD may fall into Rx frequencies of bands 42, n77 and n78.
- 3rd order IMD may fall into Rx frequencies of bands 5, 6, 8, 18, 19, 26, 32, 33, 39, 41, 45, 46, 50, 75 and n79
- 4th order IMD may fall into Rx frequencies of bands 30, 40 and n79
- 5th order IMD may fall into Rx frequencies of bands 43, n77 and n78.

It should be noted that IMD will not be an issue for band n51 (no self-interference for the TDD band) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.73.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.73.3-2: 2UL Band 1 +Band n51 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD3
	2400	-	2494	Yes	Asia	IMD3
ISM band (5GHz)	5150	-	5925	Yes	US	Harmonic3, IMD3
	5150	-	5350	Yes	Europe	IMD3
	5470	-	5725	No		
	5150	-	5825	Yes	Asia	Harmonic3, IMD3

Table 6.73.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.73.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission				
	Protected band	Frequency range (MHz)	Maximum Level (dBm)	MBW (MHz)	NOTE

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DC_1A-n51A	E-UTRA Band 7, 12, 13, 17, 20, 22, 27, 28, 29, 31, 38, 44, 48, 67, 68, 69, 72, 73	F_{DL_low} FDL_low	- - -	F_{DL_high} FDL_high	-50	1	
	E-UTRA Band 3, 34	F_{DL_low}	-	F_{DL_high}	-50	1	15
	Frequency range	1880	-	1895	-40	1	15, 27
	Frequency range	1895	-	1915	-15.5	5	15, 26, 27
	Frequency range	1915	-	1920	+1.6	5	15, 26, 27
	E-UTRA Band 5, 6, 8, 26, 30, 40, 41, 42, 43, 46 NR Band n77, n78, n79,	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 6.6.3.1-2 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 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 15: 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.

NOTE 26: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.

NOTE 27: 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.

6.73.4 ΔTIB and ΔRIB values

For DC_1A-n51A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.73.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_1A-n51A	1	0.6
	n51	0.6

Table 6.73.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_1A-n51A	n51	0.1

6.73.5 MSD

There is no specific MSD's requirement.

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6.74 DC_2A-n71A

6.74.1 Operating bands for DC

Table 6.74.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band BS receive / UE transmit $F_{UL\_low} – F_{UL\_high}$	Downlink (DL) band BS transmit / UE receive $F_{DL\_low} – F_{DL\_high}$	Duplex mode
DC_2A-n71A	2	1850 MHz – 1910 MHz	1930 MHz – 1990 MHz	FDD
	n71	663 MHz – 698 MHz	617 MHz – 652 MHz	TDD

6.74.2 Channel bandwidths per operating band for DC

Table 6.74.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_2A-n71A	2	15	Yes	Yes	Yes	Yes						40
	n71	15	Yes	Yes	Yes	Yes						
		30		Yes	Yes	Yes						
		60										

6.74.3 Co-existence studies

Table 6.1.3-1 lists Band 2 +Band n71 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.74.3-1: Band 2 and Band n71 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1850	1910	663	698
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3700	3820	1326	1396
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5550	5730	1989	2094
2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	1247	1152	2513	2608
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)	3002	3157	584	454
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)	4363	3122	3176	3306
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)	1830	1930	643	718
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)	4852	5067	79	244
Two-tone 4th order IMD products	|2*fx_low –2* fy_high|	|2*fx_high –2* fy_low|		
IMD frequency limits (MHz)	2304	2494		
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)	6213	6428	3839	4004
Two-tone 4th order IMD products	|2*fx_low +2* fy_low|	|2*fx_high +2* fy_high|		
IMD frequency limits (MHz)	5026	5216		
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)	942	742	6977	6702
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)	1606	1831	4404	4154
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)	4502	4702	8063	8338
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)	5689	5914	6876	7126

The uplink of Band n71 is 663 - 698 MHz for which third harmonic products fall within 1989 – 2094 MHz, while the downlink of Band 2 is 1930 - 1990 MHz. Thus, it can be seen that there is potential for third harmonic interference from uplink in Band 71 to downlink in Band 2. However, the potential is limited to edge channels since the overlap is only 1 MHz from 1989 – 1990 MHz. Only an uplink allocation in the lowest edge of Band 71 paired with simultaneous downlink in the uppermost edge of Band 2 could be impacted. Moreover, due to the guard bands inherent in the definition of the transmission bandwidth configuration for LTE and NR, there may not be any direct overlap at all. However, there may still be some effect due to spectral spreading of the third harmonic even if direct overlap is averted.

Another potential mechanism for harmonic interference is mixing of the uplink in Band 2 with the third harmonic of the Rx LO. In this case, the frequency range impacted is much larger. The third harmonic of Rx extends from 1851 to 1956 MHz while the uplink in Band 2 ranges from 1850 to 1910 MHz. Therefore, there is nearly complete overlap between these two ranges. Depending upon the particular frequency assignments and allocation of PRB's for uplink within Band 2 and downlink within Band n71, there may be interference from this mechanism.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.74.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.74.3-2: 2UL Band 2 +Band n71 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	Yes		IMD5
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD4
	2400	-	2494	Yes	Asia	IMD4
ISM band (5GHz)	5150	-	5925	Yes	US	H3, IMD4, 5
	5150	-	5350	Yes	Europe	IMD4
	5470	-	5725	Yes		H3, IMD4, 5
	5150	-	5825	Yes	Asia	H3, IMD4, 5

Table 6.74.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.74.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_2A-n71A	E-UTRA Band 4, 5, 12, 13, 14, 17, 24, 26, 29, 30, 48, 66	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 2, 25, 41, 70	F_{DL_low}	-	F_{DL_high}	-50	1	1
	NR Band n71	F_{DL_low}	-	F_{DL_high}	-50	1	2

Note 1 : As exceptions, measurements with a level up to the applicable requirements defined in Table 6.74.3-3 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 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 2: These requirements also apply for the frequency ranges that are less than FOOB (MHz) in Table 6.74.3-3 and [Table x.x.x.x-x] from the edge of the channel bandwidth.

Note: To simplify Table 6.74.3-3, E-UTRA band numbers are listed for bands which are specified only for E-UTRA operation. NR band numbers are listed for bands which are specified only for NR operation or both E-UTRA and NR operation

6.74.4 ΔT_{IB} and ΔR_{IB} values

For DC_2A-n71A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are reused from LTE CA_2A-71A and given in the tables below.

Table 6.74.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_2A-n71A	2	0.3
	n71	0.3

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Table 6.74.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_2A-n71A	2	0
	n71	0

6.74.5 MSD

MSD due to harmonics affects both Band 2 and Band n71. When there is uplink on low frequency channels of Band n71, its third harmonic and regrowth reach the uppermost downlink channel in Band 2. When there is uplink on Band 2, the third harmonic of Rx LO in Band n71 mixes with the uplink and generates harmonic interference in Band n71 Rx.

6.74.5.1 Band 2 MSD

The MSD from LTE CA_2A-71A is reused for this DC combination. Although the NR spectrum utilization in Band n71 is larger than the LTE spectrum utilization in Band 71, the worst case interference mechanism is expected to be single RB transmissions. The harmonic noise from single RB transmissions in Band n71 is not expected to increase due to the higher spectrum utilization.

Table 6.74.5.1-1. Summary of MSD for all aggressor and victim bandwidths

Band n71 CBW	Band 2 CBW	MSD
5	5	4.6
5	10	1.0
5	15	0.6
5	20	0.5
10	5	1.2
10	10	1.0
10	15	0.7
10	20	0.6
15	5	1.1
15	10	0.6
15	15	0.7
15	20	0.6
20	5	1.2
20	10	0.6
20	15	0.4
20	20	0.6

The reference sensitivity can be defined as follows where the maximum MSD for a given Band 2 channel bandwidth is applied. The 5 MHz channel bandwidth requires an amendment when the Band n71 Tx bandwidth is also 5 MHz since the MSD is significantly larger for this case. Also, it is noted that the MSD only applies when the channels are located in proximity of the lower edge of Band n71 and the upper edge of Band 2.

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Table 6.74.5.1-2: Reference sensitivity for carrier aggregation QPSK $P_{REFSENS, CA}$ (exceptions due to harmonic issue)

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)	100 MHz (dBm)
n71	2 NOTE 1	4.6	1.0	0.7	0.6							
	2 NOTE 2	1.7	1.0	0.7	0.6							

NOTE 1: These requirements apply when the lower edge frequency of the 5 MHz uplink channel in Band 71 is located at or below 668 MHz and the downlink channel in Band 2 is located with its upper edge at 1990 MHz.
NOTE 2: 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 2 is located with its upper edge at 1990 MHz.

Table 6.74.5.1-3: Uplink configuration for the low band (exceptions due to harmonic issue)

UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz
n71	**2**	**25^X**	**25^X**	**20^X**	**20^X**							
n71	2	8^Y	8^Y	8^Y	8^Y							

6.74.5.2 Band n71 MSD

The reference sensitivity of Band n71 is reused from Band 71 in LTE CA_2A-71A. Although the NR spectrum utilization in Band n71 is larger than the LTE spectrum utilization in Band 71, the reference sensitivity of Band n71 is dominated by the harmonic mixing noise greater than . Therefore, the slight increase in thermal noise and Tx noise due to higher spectrum utilization in Band n71 is insignificant in comparison.

Table 6.74.5.2-1: Reference sensitivity for carrier aggregation QPSK $P_{REFSENS, CA}$ (exceptions due to harmonic issue)

Channel bandwidth							
EN-DC Configuration	**EUTRA and NR band**	**SCS (kHz)**	**5 MHz (dBm)**	**10 MHz (dBm)**	**15 MHz (dBm)**	**20 MHz (dBm)**	**Duplex mode**
DC_2A-n71A[15,16]	2	15	-98	-95	-93.2	-92	FDD
	n71	15	-70.4	-70.4	-70.4	-70.4	

NOTE 15: 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 16: 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 $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$ 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 6.74.5.2-2: Uplink configuration for the low band (exceptions due to harmonic issue)

E-UTRA Band / Channel bandwidth of the high band / N_{RB} / Duplex mode							
EN-DC Configuration	**UL band**	**SCS (kHz)**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**Duplex mode**
DC_2A-n71A	2	15	25	50	50	50	FDD

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6.74.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.74.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.74.6-1.

Table 6.74.6-1: Band 2 and Band n71 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_2A_n71A	2	a	0	b	-1	3	2	Harmonic
	n71	c	3	d	0			
DC_2A_n71A	2	a	-1	b	0	3	n71	Harmonic mixing
	n71	c	0	d	3			

Equations (6.74.6.1) and (6.74.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.74.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.74.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.74.6.2)$$

Formula (6.74.6.3-1) and (6.74.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.74.6.3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.74.6.3\text{-}2)$$

6.75 DC_3A-n50A

The imcompleted combination is removed in Rel-15

6.75.1 Void

6.75.2 Void

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6.75.3 Void

6.75.4 Void

6.75.5 Void

6.76 DC_3A-n51A

6.76.1 Operating bands for DC

Table 6.76.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band BS receive / UE transmit F_{UL_low} – F_{UL_high}	Downlink (DL) band BS transmit / UE receive F_{DL_low} – F_{DL_high}	Duplex mode
DC_3A-n51A	3	1710 MHz – 1785 MHz	1805 MHz – 1880 MHz	FDD
	n51	1427 MHz – 1432 MHz	1427 MHz – 1432 MHz	TDD

6.76.2 Channel bandwidths per operating band for DC

		DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Maximum aggregated bandwidth [MHz]
DC_3A-n51A	3	15	Yes	Yes	Yes	Yes								25
	n51	15	Yes											
		30												
		60												

6.76.3 Co-existence studies

Table 6.76.3-1 lists Band 3 + Band n51 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.76.3-1: Band 3 and Band n51 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1427	1432	1710	1785
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	2854	2864	3420	3570
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	4281	4296	5130	5355
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)	278	358	3137	3217
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)	1069	1154	1988	2143
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)	4564	4649	4847	5002
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)	1407	1452	1705	1790
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)	2496	2586	3698	3928
Two-tone 4th order IMD products	(2*fy_low – 2*fx_high)	(2*fy_high – 2*fx_low)		
IMD frequency limits (MHz)	556	716		
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)	5991	6081	6557	6787
Two-tone 4th order IMD products	(2*fx_low + 2*fy_low)	(2*fx_high + 2*fy_high)		
IMD frequency limits (MHz)	6274	6434		
Two-tone 5th 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)	5408	5713	3923	4018
Two-tone 5th 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)	2266	2501	876	711
Two-tone 5th 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)	8267	8572	7418	7513
Two-tone 5th 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)	7984	8219	7701	7866

Based on Table 6.76.3-1

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- 2rd order harmonic may fall into Rx frequencies of bands 22, 42, n77 and n78.
- 3rd order harmonic may fall into Rx frequencies of band 46.
- 3rd order IMD may fall into Rx frequencies of bands 1, 21, 32, 34, 36, 45, 50, 65, 66, 70, 75, and n79.
- 4th order IMD may fall into Rx frequencies of bands 38, 41, 43, 44, 69, 71, n77 and n78
- 5th order IMD may fall into Rx frequencies of bands 5, 6, 19, 26, 30, 40, 41, 46 and n77.

It should be noted that IMD will not be an issue for band n51 (no self-interference for the TDD band) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.76.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.76.3-2: 2UL Band 3 +Band n51 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD5
	2400	-	2494	Yes	Asia	IMD5
ISM band (5GHz)	5150	-	5925	Yes	US	Harmonic3, IMD5
	5150	-	5350	Yes	Europe	Harmonic3
	5470	-	5725	Yes		IMD5
	5150	-	5825	Yes	Asia	Harmonic3, IMD5

Table 6.76.3-3 lists the protected bands required for the dual connectivity configuration.

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Table 6.76.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_3A-n51A	E-UTRA Band 7, 8, 12, 13, 17, 20, 27, 28, 31, 33, 38, 48, 67, 68, 69, 72, 73	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 3	F_{DL_low}	-	F_{DL_high}	-50	1	15
	E-UTRA Band 1, 5, 6, 22, 26, 30, 34, 36, 40, 41, 42, 43, 44, 46, 65, 71	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 6.6.3.1-2 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 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 15: 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.

6.76.4 ΔTIB and ΔRIB values

For DC_3A-n51A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.76.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_3A-n51A	3	0.3
	n51	0.3

Table 6.76.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_3A-n51A	3	0.2
	n51	0.2

6.76.5 MSD

DC_3A_n51A is subjected to MSD due to cross band isolation referring same mechanism of DC_11A_n3A (R4-2002558) result with further calculations to all channel bandwidths. The MSD due to cross band isolation is calculated as below tables:

Table 6.75.5-1: Reference sensitivity exceptions (MSD) due to cross band isolation for EN-DC in NR FR1

	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)
3	n51	6.4											

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Table 6.75.5-2: Uplink configuration for reference sensitivity exceptions due to cross band isolation for EN-DC in NR FR1

	E-UTRA or NR Band / SCS / Channel bandwidth of the affected DL band / UL RB allocation of the agressor band													
UL band	DL band	SCS of UL band (kHz)	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})	80 MHz (L_{CRB})	90 MHz (L_{CRB})	100 MHz (L_{CRB})
3	n51	15	25											

6.77 DC_7A-n50A

6.77.1 Operating bands for DC

Table 6.77.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_7A-n50A	7	2500 MHz – 2570 MHz	2620 MHz – 2690 MHz	FDD
	n50	1432 MHz – 1517 MHz	1432 MHz – 1517 MHz	TDD

6.77.2 Channel bandwidths per operating band for DC

Table 6.77.2-1

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Maximum aggregated bandwidth [MHz]
DC_7A-n50A	7	15	Yes	Yes	Yes	Yes								100
	n50	15	Yes	Yes	Yes	Yes			Yes	Yes				
		30		Yes	Yes	Yes			Yes	Yes	Yes	Yes[3]		
		60		Yes	Yes	Yes			Yes	Yes	Yes	Yes[3]		
NOTE 3: This UE channel bandwidth is applicable only to downlink.														

6.77.3 Co-existence studies

Table 6.77.3-1 lists Band 7 + Band n50 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.77.3-1: Band 1 and Band n50 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	**1432**	**1517**	**2500**	**2570**
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	2864	3034	5000	5140
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	4296	4551	7500	7710
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)	983	1138	3932	4087
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)	294	534	3483	3708
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)	5364	5604	6432	6657
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)	1412	1537	2440	2630
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)	1726	2051	5983	6278
Two-tone 4th order IMD products	(2*fy_low – 2*fx_high)	(2*fy_high – 2*fx_low)		
IMD frequency limits (MHz)	1966	2276		
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)	6796	7121	8932	9227
Two-tone 4th order IMD products	(2*fx_low + 2*fy_low)	(2*fx_high + 2*fy_high)		
IMD frequency limits (MHz)	7864	8174		
Two-tone 5th 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)	8483	8848	3158	3568
Two-tone 5th 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)	4466	4846	449	844
Two-tone 5th 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)	11432	11797	8228	8638
Two-tone 5th 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)	10364	10744	9296	9691

Based on Table 6.77.3-1

3rd order harmonic may fall into Rx frequencies of band n79.

2nd order IMD may fall into Rx frequencies of band n77.

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3rd order IMD may fall into Rx frequencies of bands 22, 24, 31, 38, 42, 43, 46, 69, 72, n77 and n78,

4th order IMD may fall into Rx frequencies of bands 1, 2, 3, 4, 9, 10, 23, 25, 33, 34, 35, 36, 37, 39, 65, 66 and 70.

5th order IMD may fall into Rx frequencies of bands 12, 13, 14, 17, 20, 22, 28, 29, 31, 42, 44, 67, 68, 71, 72, n77, n78 and n79.

It should be noted that IMD will not be an issue for band n50 (no self-interference for the TDD band) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.77.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.77.3-2: 2UL Band 7 +Band n50 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD3
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	Yes		IMD3
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD3
	2400	-	2494	Yes	Asia	IMD3
ISM band (5GHz)	5150	-	5925	Yes	US	IMD3
	5150	-	5350	No	Europe	
	5470	-	5725	Yes		IMD3
	5150	-	5825	Yes	Asia	IMD3

Table 6.77.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.77.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission				
	Protected band	Frequency range (MHz)	Maximum Level (dBm)	MBW (MHz)	NOTE

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DC_7A-n50A	E-UTRA Band 2, 3, 5, 8, 26, 30, 31, 33, 34, 39, 40, 48, 72	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	2570	-	2575	+1.6	5	15, 21, 26
	Frequency range	2575	-	2595	-15.5	5	15, 21, 26
	Frequency range	2595	-	2620	-40	1	15, 21
	E-UTRA Band 1, 4, 10, 12, 13, 14, 17, 20, 22, 23, 27, 28, 29, 42, 43, 44, 46, 65, 66, 67, 68 NR Band n77, n78, n79,	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 6.6.3.1-2 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 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 15: 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.

NOTE 21: 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 26: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.

6.77.4 ΔTIB and ΔRIB values

For DC_7A-n50A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.77.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_7A-n50A	7	0.3
	n50	0.3

Table 6.77.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_7A-n50A	n50	0.2

6.77.5 MSD

There is no specific MSD's requirement.

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6.78 DC_7A-n51A

6.78.1 Operating bands for DC

Table 6.78.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_7A-n51A	7	2500 MHz – 2570 MHz	2620 MHz – 2690 MHz	FDD
	n51	1427 MHz – 1432 MHz	1427 MHz – 1432 MHz	TDD

6.78.2 Channel bandwidths per operating band for DC

Table 6.78.2-1

		DC operating / channel bandwidth													
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Maximum aggregated bandwidth [MHz]
DC_7A-n51A	7	15	Yes	Yes	Yes	Yes								25
	n51	15	Yes											
		30												
		60												

6.78.3 Co-existence studies

Table 6.78.3-1 lists Band 7 + Band n51 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.78.3-1: Band 7 and Band n51 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1427	1432	2500	2570
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	2854	2864	5000	5140
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	4281	4296	7500	7710
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)	1068	1143	3927	4002
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)	284	364	3568	3713
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)	5354	5434	6427	6572

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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)	1407	1452	2495	2575
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)	1711	1796	6068	6283
Two-tone 4th order IMD products	(2*fy_low – 2*fx_high)	(2*fy_high – 2*fx_low)		
IMD frequency limits (MHz)	2136	2286		
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)	6781	6866	8927	9142
Two-tone 4th order IMD products	(2*fx_low + 2*fy_low)	(2*fx_high + 2*fy_high)		
IMD frequency limits (MHz)	7854	8004		
Two-tone 5th 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)	8568	8853	3138	3228
Two-tone 5th 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)	4636	4856	704	859
Two-tone 5th 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)	11427	11712	8208	8298
Two-tone 5th 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)	10354	10574	9281	9436

Based on Table 6.78.3-1

2nd order IMD may fall into Rx frequencies of band n77.

3rd order IMD may fall into Rx frequencies of bands 21, 22, 32, 38, 42, 43, 45, 46, 50, 69, 75, n77 and n78.

4th order IMD may fall into Rx frequencies of bands 1, 4, 10, 23, 65 and 66

5th order IMD may fall into Rx frequencies of bands 12, 13, 14, 17, 20, 27, 28, 29, 44, 67, 68 and n79.

It should be noted that IMD will not be an issue for band n51 (no self-interference for the TDD band) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.78.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.78.3-2: 2UL Band 7 +Band n51 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	Yes	US	IMD3
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	Yes	Asia	IMD3

Table 6.78.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.78.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_7A-n51A	E-UTRA Band 2, 3, 5, 8, 26, 30, 31, 32, 33, 34, 40, 48, 72	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	2570	-	2575	+1.6	5	15, 21, 26
	Frequency range	2575	-	2595	-15.5	5	15, 21, 26
	Frequency range	2595	-	2620	-40	1	15, 21
	E-UTRA Band 1, 4, 10, 12, 13, 14, 17, 20, 22, 23, 27, 28, 29, 42, 43, 44, 46, 65, 66, 67, 68 NR Band n77, n78, n79,	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 6.6.3.1-2 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 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 15: 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.

NOTE 21: 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 26: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band.

6.78.4 ΔTIB and ΔRIB values

For DC_7A-n51A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

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Table 6.78.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_7A-n51A	7	0.3
	n51	0.3

Table 6.78.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_7A-n51A	n51	0.2

6.78.5 MSD

There is no specific MSD's requirement.

6.79 DC_20A-n50A

6.79.1 Operating bands for DC

Table 6.79.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_20A-n50A	20	832 MHz – 862 MHz	791 MHz – 821 MHz	FDD
	n50	1432 MHz – 1517 MHz	1432 MHz – 1517 MHz	TDD

6.79.2 Channel bandwidths per operating band for DC

Table 6.79.2-1

		DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Maximum aggregated bandwidth [MHz]
DC_20A-n50A	20	15	Yes	Yes	Yes	Yes								100
	n50	15	Yes	Yes	Yes	Yes			Yes	Yes				
		30		Yes	Yes	Yes			Yes	Yes	Yes	Yes[3]		
		60		Yes	Yes	Yes			Yes	Yes	Yes	Yes[3]		
NOTE 3: This UE channel bandwidth is applicable only to downlink.														

6.79.3 Co-existence studies

Table 6.79.3-1 lists Band 20 + Band n50 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.79.3-1: Band 20 and Band n50 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	**832**	**862**	**1432**	**1517**
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1664	1724	2864	3034
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2496	2586	4296	4551
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)	570	685	2264	2379
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)	147	292	2002	2202
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)	3096	3241	3696	3896
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)	772	922	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)	979	1154	3434	3719
Two-tone 4th order IMD products	(2*fy_low – 2*fx_high)	(2*fy_high – 2*fx_low)		
IMD frequency limits (MHz)	1140	1370		
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)	3928	4103	5128	5413
Two-tone 4th order IMD products	(2*fx_low + 2*fy_low)	(2*fx_high + 2*fy_high)		
IMD frequency limits (MHz)	4528	4758		
Two-tone 5th 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)	4866	5236	1811	2016
Two-tone 5th 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)	2572	2887	278	538
Two-tone 5th 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)	6560	6930	4760	4965
Two-tone 5th 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)	5960	6275	5360	5620

Based on Table 6.79.3-1

3rd order harmonic may fall into Rx frequencies of bands 38, 41, 69 and n79.

2nd order IMD may fall into Rx frequencies of bands 30, 40 and 71.

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3rd order IMD may fall into Rx frequencies of bands 1, 4, 6, 8, 10, 13, 18, 23, 24, 26, 28, 34, 43, 65, 66, 67, 68, 70, n77 and n78.

4th order IMD may fall into Rx frequencies of bands 22, 42, 43, 46, n77, n78 and n79.

5th order IMD may fall into Rx frequencies of bands 2, 3, 7, 9, 25, 31, 33, 34, 35, 36, 37, 38, 39, 41, 46, 69, 70, 72, and n79

It should be noted that IMD will not be an issue for band n50 (no self-interference for the TDD band) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.79.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.79.3-2: 2UL Band 20 +Band n50 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	Yes	US	IMD4, 5
	5150	-	5350	Yes	Europe	IMD4, 5
	5470	-	5725	Yes		IMD5
	5150	-	5825	Yes	Asia	IMD4, 5

Table 6.79.3-3 lists the protected bands required for the dual connectivity configuration.

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Table 6.79.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_20A-n50A	E-UTRA Band 48	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 20	F_{DL_low}	-	F_{DL_high}	-50	1	15
	Frequency range	758	-	788	-50	1	
	E-UTRA Band 1, 2, 3, 4, 7, 8, 9, 10, 13, 22, 23, 25, 30, 31, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 46, 65, 66, 67, 69, 70, 72 NR Band n77, n78, n79,	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 6.6.3.1-2 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 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 15: 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.							

6.79.4 ΔTIB and ΔRIB values

For DC_20A-n50A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.79.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_20A-n50A	20	0.5
	n50	0.5

Table 6.79.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_20A-n50A	n50	0.2

6.79.5 MSD

There is no specific MSD's requirement.

6.80 DC_20A-n51A

6.80.1 Operating bands for DC

Table 6.80.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_20A-n51A	20	832 MHz – 862 MHz	791 MHz – 821 MHz	FDD
	n51	1427 MHz – 1432 MHz	1427 MHz – 1432 MHz	TDD

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6.80.2 Channel bandwidths per operating band for DC

Table 6.80.2-1

		DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	**E-UTRA and NR Band**	**Subcarrier spacing [kHz]**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**25 MHz**	**30 MHz**	**40 MHz**	**50 MHz**	**60 MHz**	**80 MHz**	**100 MHz**	**Maximum aggregated bandwidth [MHz]**
DC_20A-n51A	20	15	Yes	Yes	Yes	Yes								25
	n51	15	Yes											
		30												
		60												

6.80.3 Co-existence studies

Table 6.80.3-1 lists Band 20 + Band n51 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.80.3-1: Band 20 and Band n51 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	**832**	**862**	**1427**	**1432**
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1664	1724	2854	2864
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2496	2586	4281	4296
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)	565	600	2259	2294
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)	232	297	1992	2032
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)	3091	3156	3686	3726
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)	827	867	1407	1452
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)	1064	1159	3419	3464
Two-tone 4th order IMD products	(2*fy_low – 2*fx_high)	(2*fy_high – 2*fx_low)		
IMD frequency limits (MHz)	1130	1200		
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)	3923	4018	5113	5158
Two-tone 4th order IMD products	(2*fx_low + 2*fy_low)	(2*fx_high + 2*fy_high)		
IMD frequency limits (MHz)	4518	4588		
Two-tone 5th 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)	4846	4896	1896	2021
Two-tone 5th 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)	2557	2632	268	368
Two-tone 5th 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)	6540	6590	4755	4880
Two-tone 5th 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)	5945	6020	5350	5450

Based on Table 6.80.3-1

3rd order harmonic may fall into Rx frequencies of bands 38, 41 and 69.

3rd order IMD may fall into Rx frequencies of bands 25, 32, 34, 43, 45, 50, 70, 75, n77 and n78

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4th order IMD may fall into Rx frequencies of bands 42, 46, n77, n78 and n79.

5th order IMD may fall into Rx frequencies of bands 2, 7, 25, 33, 34, 35, 36, 37, 38, 39, 41, 46, 69, 70, and n79.

It should be noted that IMD will not be an issue for band n51 (no self-interference for the TDD band) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.80.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.80.3-2: 2UL Band 20 +Band n51 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	Yes	US	IMD4, 5
	5150	-	5350	Yes	Europe	IMD4
	5470	-	5725	No		
	5150	-	5825	Yes	Asia	IMD4, 5

Table 6.80.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.80.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_20A-n51A	E-UTRA Band 1, 3, 4, 8, 17, 22, 28, 29, 31, 40, 43, 48, 65, 66, 68, 72	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 20	F_{DL_low}	-	F_{DL_high}	-50	1	15
	Frequency range	758	-	788	-50	1	
	E-UTRA Band 2, 7, 25, 32, 33, 34, 35, 36, 37, 38, 39, 41, 42, 46, 69, 70 NR Band n77, n78, n79,	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 6.6.3.1-2 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 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 15: 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.

6.80.4 ΔTIB and ΔRIB values

For DC_20A-n51A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

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Table 6.80.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_20A-n51A	20	0.5
	n51	0.5

Table 6.80.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_20A-n51A	n51	0.2

6.80.5 MSD

There is no specific MSD's requirement.

6.81 DC_28A-n50A

6.81.1 Operating bands for DC

Table 6.81.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_28A-n50A	28	703 MHz – 748 MHz	758 MHz – 803 MHz	FDD
	n50	1432 MHz – 1517 MHz	1432 MHz – 1517 MHz	TDD

6.81.2 Channel bandwidths per operating band for DC

Table 6.81.2-1

		DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Maximum aggregated bandwidth [MHz]
DC_28A-n50A	28	15	Yes	Yes	Yes	Yes								100
	n50	15	Yes	Yes	Yes	Yes			Yes	Yes				
		30		Yes	Yes	Yes			Yes	Yes	Yes	Yes[3]		
		60		Yes	Yes	Yes			Yes	Yes	Yes	Yes[3]		
NOTE 3: This UE channel bandwidth is applicable only to downlink.														

6.81.3 Co-existence studies

Table 6.81.3-1 lists Band 28 + Band n50 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.81.3-1: Band 28 and Band n50 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	**703**	**748**	**1432**	**1517**
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1406	1496	2864	3034
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2109	2244	4296	4551
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
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 5th 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 5th 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 5th 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 5th 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 Table 6.81.3-1

3rd order harmonic may fall into Rx frequencies of band 1, 4, 10, 23, 65, 66 and n79.

2nd order IMD may fall into Rx frequencies of bands 1, 4, 10, 20, 23, 28, 65, 66 and 67.

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3rd order IMD may fall into Rx frequencies of bands 1, 4, 10, 20, 22, 23, 24, 28, 40, 42, 43, 65, 66, 67, 71, n77, and n78.

4th order IMD may fall into Rx frequencies of bands 20, 22, 24, 28, 42, 43, 46, 67, 71, n77, n78, and n79

5th order IMD may fall into Rx frequencies of bands 5, 6,, 18, 19, 20, 24, 26, 27, 28, 46, 67, 71, and n79

It should be noted that IMD will not be an issue for band n50 (no self-interference for the TDD band) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.81.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.81.3-2: 2UL Band 28 +Band n50 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD3, 4, 5
Galileo	1559	-	1591	Yes		IMD3, 4, 5
GLONASS	1591	-	1610	Yes		IMD4
GPS	1563	-	1587	Yes		IMD4
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	Yes	US	IMD4, 5
	5150	-	5350	Yes	Europe	IMD4, 5
	5470	-	5725	Yes		IMD5
	5150	-	5825	Yes	Asia	IMD4, 5

Table 6.81.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.81.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission				
	Protected band	Frequency range (MHz)	Maximum Level (dBm)	MBW (MHz)	NOTE

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DC_28A-n50A	E-UTRA Band 2, 3, 7, 8, 25, 29, 31, 34, 38, 39, 41, 48, 72	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 4, 6, 10, 22, 23, 24, 20, 40, 42, 43, 46, 65, 66, 73 NR band n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1	2
	E-UTRA Band 1	F_{DL_low}	-	F_{DL_high}	-50	1	2, 19, 25
	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	

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 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 15: 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.

NOTE 19: 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 25: 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 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 34: 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 35: 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.

6.81.4 ΔTIB and ΔRIB values

For DC_28A-n50A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.81.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_28A-n50A	28	0.5
	n50	0.5

Table 6.81.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_28A-n50A	n50	0.2

6.81.5 MSD

It may have 2nd, 3rd, 4th, 5th order IMDs when the UP of the band 28 and the UP of the band n50 is used in the same time without precaution. Thus, if the UL of the both bands are not used in the same time, all IMD issues are canceled, and there is no MSD issue for this DC configuration

Table 6.81.5-1 lists the MSD required for the dual connectivity configuration DC_28A_n50A.

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Table 6.81.5-1: MSD for the DC configuration

E-UTRA and NR Band / Channel bandwidth / N_{RB} / Duplex mode / MSD / Single UL									
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	IMD order	Single UL allowed
DC_28A-n50A	28	725.5	20	25	765.5	5	FDD	IMD 4, 5	Yes
	n50	1474.5	60	50	1474.5	5	TDD	IMD 4, 5	

6.81.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.81.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.81.6-1.

Table 6.81.6-1: Band 28 and Band n50 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_28A_n50A	28	a	-1	b	-1	2	28	IMD
	n50	c	1	d	0			
DC_28A_n50A	28	a	3	b	-1	4	28	IMD
	n50	c	-1	d	0			
DC_28A_n50A	28	a	-3	b	-1	5	28	IMD
	n50	c	2	d	0			
DC_28A_n50A	28	a	2	b	0	2	n50	Harmonic
	n50	c	0	d	-1			

Equations (6.81.6.1) and (6.81.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.81.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.81.6.1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.81.6.2)$$

Formula (6.81.6.3-1) and (6.81.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.81.6.3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.81.6.3\text{-}2)$$

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6.82 DC_28A-n51A

6.82.1 Operating bands for DC

Table 6.82.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_28A-n51A	28	703 MHz – 748 MHz	758 MHz – 803 MHz	FDD
	n51	1427 MHz – 1432 MHz	1427 MHz – 1432 MHz	TDD

6.82.2 Channel bandwidths per operating band for DC

Table 6.82.2-1

		DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Maximum aggregated bandwidth [MHz]
DC_28A-n51A	28	15	Yes	Yes	Yes	Yes								25
	n51	15	Yes											
		30												
		60												

6.82.3 Co-existence studies

Table 6.82.3-1 lists Band 28 + Band n51 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.82.3-1: Band 28 and Band n51 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	**703**	**748**	**1427**	**1432**
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1406	1496	2854	2864
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2109	2244	4281	4296
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)	679	729	2130	2180
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)	26	69	2106	2161
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)	2833	2928	3557	3612
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)	698	753	1407	1452
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)	677	817	3533	3593
Two-tone 4th order IMD products	(2*fy_low – 2*fx_high)	(2*fy_high – 2*fx_low)		
IMD frequency limits (MHz)	1358	1458		
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)	3536	3676	4984	5044
Two-tone 4th order IMD products	(2*fx_low + 2*fy_low)	(2*fx_high + 2*fy_high)		
IMD frequency limits (MHz)	4260	4360		
Two-tone 5th 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)	4960	5025	1380	1565
Two-tone 5th 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)	2785	2890	610	755
Two-tone 5th 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)	6411	6476	4239	4424
Two-tone 5th 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)	5687	5792	4963	5108

Based on Table 6.82.3-1

2nd order harmonic may fall into Rx frequencies of band 21, 32, 45, 50, n51 own RX range, 75 and 76.

3rd order harmonic may fall into Rx frequencies of band 1, 4, 10, 23, 65 and 66.

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2nd order IMD may fall into Rx frequencies of bands 1, 4, 10, 65 and 66.

3rd order IMD may fall into Rx frequencies of bands 1, 4, 10, 22, 32, 42, 43, 45, 50, 65, 66, 75, n77 and n78.

4th order IMD may fall into Rx frequencies of bands 20, 22, 28, 32, 42, 43, 45, 50, 67, 75, n77, n78 and n79.

5th order IMD may fall into Rx frequencies of bands 21, 24, 32, 45, 46, 50, 67, 71, 75, and n79.

It should be noted that IMD will not be an issue for band n51 (no self-interference for the TDD band) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.82.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.82.3-2: 2UL Band 28 +Band n51 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD5
Galileo	1559	-	1591	Yes		IMD5
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	Yes		IMD4
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	Yes	US	IMD5
	5150	-	5350	No	Europe	
	5470	-	5725	Yes		IMD5
	5150	-	5825	Yes	Asia	IMD5

Table 6.82.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.82.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission				
	Protected band	Frequency range (MHz)	Maximum Level (dBm)	MBW (MHz)	NOTE

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DC_28A-n51A	E-UTRA Band 2, 3, 5, 7, 8, 25, 26, 31, 34, 38, 40, 41, 66, 72	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 4, 10, 20, 22, 24, 32, 42, 43, 45, 46, 65, 66, 71, 73 NR band n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1	2
	E-UTRA Band 1	F_{DL_low}	-	F_{DL_high}	-50	1	2, 19, 25
	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	

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 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 15: 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.

NOTE 19: 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 25: 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 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 34: 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 35: 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.

6.82.4 ΔTIB and ΔRIB values

For DC_28A-n51A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.82.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_28A-n51A	28	0.5
	n51	0.5

Table 6.82.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_28A-n51A	n51	0.2

6.82.5 MSD

It may have 2nd, 3rd, 4th, 5th order IMDs when the UP of the band 28 and the UP of the band n51 is used in the same time without precaution. Thus, if the UL of the both bands are not used in the same time, all IMD issues are canceled, and there is no MSD issue for this DC configuration

Table 6.81.5-1 lists the MSD required for the dual connectivity configuration DC_28A_n51A.

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Table 6.81.5-1: MSD for the DC configuration

E-UTRA and NR Band / Channel bandwidth / N_{RB} / Duplex mode / MSD / Single UL									
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	IMD order	Single UL allowed
DC_28A-n51A	28	725.5	20	25	765.5	5	FDD	IMD 4, 5	Yes
	n51	1429.5	5	25	1429.5	5	TDD	IMD 4, 5	

MSD due to B28 uplink harmonic is derived from LTE CA_28A-32A.

Table 6.81.5-2: Reference sensitivity exceptions (MSD) due to UL harmonic for EN-DC in NR FR1

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)
28	n51[2]	27.8											
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 $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$ with carrier frequency in the victim (higher) band in MHz and the channel bandwidth configured in the lower band.													

Table 6.81.5-3: Uplink configuration for reference sensitivity exceptions due to UL harmonic interference for EN-DC in NR FR1

	E-UTRA or NR Band / Channel bandwidth of the affected DL band / UL RB allocation of the agressor 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})	80 MHz (L_{CRB})	90 MHz (L_{CRB})	100 MHz (L_{CRB})
28	n51	12											

6.82.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.82.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.82.6-1.

Table 6.82.6-1: Band 28 and Band n51 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_28A_n51A	28	a	3	b	-1	4	28	IMD
	n51	c	-1	d	0			
DC_28A_n51A	28	a	2	b	0	2	n51	Harmonic
	n51	c	0	d	-1			

Equations (6.82.6.1) and (6.82.6.2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.82.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.82.6.1)$$

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$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.82.6.2)$$

Formula (6.82.6.3-1) and (6.82.6.3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.82.6.3\text{-}1)$$

$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.82.6.3\text{-}2)$$

6.83 DC_42A-n50A

6.83.1 Operating bands for DC

Table 6.83.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_42A-n50A	42	3400 MHz – 3600 MHz	3400 MHz – 3600 MHz	TDD
	n50	1432 MHz – 1517 MHz	1432 MHz – 1517 MHz	TDD

6.83.2 Channel bandwidths per operating band for DC

Table 6.83.2-1

		DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Maximum aggregated bandwidth [MHz]
DC_42A-n50A	42	15	Yes	Yes	Yes	Yes								100
	n50	15	Yes	Yes	Yes	Yes			Yes	Yes				
		30		Yes	Yes	Yes			Yes	Yes	Yes	Yes[3]		
		60		Yes	Yes	Yes			Yes	Yes	Yes	Yes[3]		
NOTE 3: This UE channel bandwidth is applicable only to downlink.														

6.83.3 Co-existence studies

Table 6.83.3-1 lists Band 42 + Band n50 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.83.3-1: Band 42 and Band n50 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	**1432**	**1517**	**3400**	**3600**
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	2864	3034	6800	7200
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	4296	4551	10200	10800
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)	1883	2168	4832	5117
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)	366	736	5283	5768
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)	6264	6634	8232	8717
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)	1412	1537	3340	3660
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)	696	1151	8683	9368
Two-tone 4th order IMD products	(2*fy_low – 2*fx_high)	(2*fy_high – 2*fx_low)		
IMD frequency limits (MHz)	3766	4336		
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)	7696	8151	11632	12317
Two-tone 4th order IMD products	(2*fx_low + 2*fy_low)	(2*fx_high + 2*fy_high)		
IMD frequency limits (MHz)	9664	10234		
Two-tone 5th 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)	12083	12968	2128	2668
Two-tone 5th 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)	7166	7936	2249	2904
Two-tone 5th 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)	15032	15917	9128	9668
Two-tone 5th 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)	13064	13834	11096	11751

Based on Table 6.83.3-1

3rd order harmonic may fall into Rx frequencies of band n79.

2nd order IMD may fall into Rx frequencies of bands 1, 2, 4, 10, 25, 33, 34, 36, 37, 39, 65, 67, 70 and n79.

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3rd order IMD may fall into Rx frequencies of bands 12, 17, 24, 29, 31, 44, 46, 71 and 72.

4th order IMD may fall into Rx frequencies of bands 5, 6, 8, 12, 13, 14, 17, 18, 19, 20, 26, 27, 28, 29, 43, 44, 67 and 68.

5th order IMD may fall into Rx frequencies of bands 1, 4, 7, 10, 23, 30, 38, 40, 41, 65, 66 and 69.

It should be noted that IMD will not be an issue for band n50 or band 42 (no self-interference for the TDD band) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.83.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.83.3-2: 2UL Band 42 +Band n50 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD3
Galileo	1559	-	1591	Yes		IMD3
GLONASS	1591	-	1610	Yes		IMD3
GPS	1563	-	1587	Yes		IMD3
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD5
	2400	-	2494	Yes	Asia	IMD5
ISM band (5GHz)	5150	-	5925	Yes	US	IMD3
	5150	-	5350	Yes	Europe	IMD3
	5470	-	5725	Yes		IMD3
	5150	-	5825	Yes	Asia	IMD3

Table 6.83.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.83.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_42A-n50A	E-UTRA Band 3, 72, 73	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 1, 2, 4, 5, 6, 7, 8, 10, 12, 13, 14, 17, 20, 23, 25, 26, 27, 28, 29, 30, 31, 33, 34, 36, 37, 38, 39, 40, 41, 44, 46, 65, 66, 67, 68, 69 NR Band 79	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 6.6.3.1-2 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 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.

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6.83.4 ΔTIB and ΔRIB values

For DC_42A-n50A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.83.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_42A-n50A	42	0.6
	n50	0.8

Table 6.83.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_42A-n50A	n50	0.2

6.83.5 MSD

There is no specific MSD's requirement.

6.84 DC_42A-n51A

6.84.1 Operating bands for DC

Table 6.84.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band BS receive / UE transmit $F_{UL\_low} – F_{UL\_high}$	Downlink (DL) band BS transmit / UE receive $F_{DL\_low} – F_{DL\_high}$	Duplex mode
DC_42A-n51A	42	3400 MHz – 3600 MHz	3400 MHz – 3600 MHz	TDD
	n51	1427 MHz – 1432 MHz	1427 MHz – 1432 MHz	TDD

6.84.2 Channel bandwidths per operating band for DC

Table 6.82.2-1

		DC operating / channel bandwidth													
E-UTRA and NR DC Configuration	**E-UTRA and NR Band**	**Subcarrier spacing [kHz]**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**25 MHz**	**30 MHz**	**40 MHz**	**50 MHz**	**60 MHz**	**80 MHz**	**100 MHz**	**Maximum aggregated bandwidth [MHz]**
DC_42A-n51A	42	15	Yes	Yes	Yes	Yes								25
	n51	15	Yes											
		30												
		60												

6.84.3 Co-existence studies

Table 6.84.3-1 lists Band 42 + Band n51 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.84.3-1: Band 42 and Band n51 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	**1427**	**1432**	**3400**	**3600**
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	2854	2864	6800	7200
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	4281	4296	10200	10800
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)	1968	2173	4827	5032
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)	536	746	5368	5773
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)	6254	6464	8227	8632
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)	1407	1452	3395	3605
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)	681	896	8768	9373
Two-tone 4th order IMD products	(2*fy_low – 2*fx_high)	(2*fy_high – 2*fx_low)		
IMD frequency limits (MHz)	3936	4346		
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)	7681	7896	11627	12232
Two-tone 4th order IMD products	(2*fx_low + 2*fy_low)	(2*fx_high + 2*fy_high)		
IMD frequency limits (MHz)	9654	10064		
Two-tone 5th 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)	12168	12973	2108	2328
Two-tone 5th 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)	7336	7946	2504	2919
Two-tone 5th 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)	15027	15832	9108	9328
Two-tone 5th 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)	13054	13664	11081	11496

Based on Table 6.84.3-1

2nd order IMD may fall into Rx frequencies of bands 1, 2, 4, 10, 25, 34, 36, 65, 66 and 70.

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3rd order IMD may fall into Rx frequencies of bands 12, 17, 21, 22, 24, 29, 32, 43, 44, 45, 46, 50, 67, 71, 75, n77 and n78

4th order IMD may fall into Rx frequencies of bands 5, 6, 12, 13, 14, 17, 18, 19, 20, 26, 27, 28, 29, 44, 67, 68 and n77.

5th order IMD may fall into Rx frequencies of bands 1, 4, 7, 10, 23, 38, 40, 41, 65, 66 and 69.

It should be noted that IMD will not be an issue for band n51 or band 42 (no self-interference for the TDD band) even through the IMD products may fall into the concerning band.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.84.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.84.3-2: 2UL Band 42 +Band n51 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD3
Galileo	1559	-	1591	Yes		IMD3
GLONASS	1591	-	1610	Yes		IMD3
GPS	1563	-	1587	Yes		IMD3
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	Yes	US	IMD3
	5150	-	5350	No	Europe	
	5470	-	5725	Yes		IMD3
	5150	-	5825	Yes	Asia	IMD3

Table 6.84.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.84.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_42A-n51A	E-UTRA Band 3, 8, 20, 25, 30, 31, 34, 39, 41, 73	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 1, 2, 4, 5, 6, 7, 10, 12, 13, 14, 17, 23, 24, 26, 27, 28, 29, 32, 38, 40, 44, 46, 65, 66, 67, 68, 70, 71	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 6.6.3.1-2 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 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.							

6.84.4 ΔTIB and ΔRIB values

For DC_42A-n51A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

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Table 6.84.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_42A-n51A	42	0.6
	n51	0.8

Table 6.84.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_42A-n51A	n51	0.2

6.84.5 MSD

There is no specific MSD's requirement.

6.85 DC_66A_n260

6.85.1 Operating bands for DC

Table 6.85.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band Combination	E-UTRA and NR Band	Uplink (UL) band BS receive / UE transmit F_{UL_low} – F_{UL_high}	Downlink (DL) band BS transmit / UE receive F_{DL_low} – F_{DL_high}	Duplex mode
DC_66A_n260	66	1710 MHz – 1780 MHz	2110 MHz – 2200 MHz	FDD
	n260	37000 MHz – 40000 MHz	37000 MHz – 40000 MHz	TDD

6.85.2 Channel bandwidths per operating band for DC

Table 6.85.2-1 Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and 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]	Fallba Group

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DC_66A_n260A	66	15	Yes	Yes	Yes	Yes								420 (220 for Band n260 with 60kHz SCS)	
	n260	60						Yes			Yes	Yes			
		120						Yes			Yes	Yes	Yes		
DC_66A_n260(2A)	66	15	Yes	Yes	Yes	Yes								820 (420 for Band n260 with 60 kHz SCS)	
	n260	60	See CA_n260(2A) Bandwidth Combination in Table 5.5A.2-1 of 38.101-2 [4]												
		120													
DC_66A_n260A(3A)	66	15	Yes	Yes	Yes	Yes								1220 (620 for Band n260 with 60 kHz SCS)	
	n260	60	See CA_n260(3A) Bandwidth Combination in Table 5.5A.2-1 of 38.101-2 [4]												
		120													
DC_66A_n260A(4A)	66	15	Yes	Yes	Yes	Yes								1620 (820 for Band n260 with 60 kHz SCS)	
	n260	60	See CA_n260(4A) Bandwidth Combination in Table 5.5A.2-1 of 38.101-2 [4]												
		120													
DC_66A-n260B	66	15	Yes	Yes	Yes	Yes									1
	n260	60	See CA_n260B Bandwidth Combination Fall-back Group 1 in Table 6.X.2-1												
		120												820	
DC_66A-n260C	66	15	Yes	Yes	Yes	Yes									
	n260	60	See CA_n260C Bandwidth Combination Fall-back Group 1 in Table 6.X.2-1												
		120												1220	
DC_66A-n260D	66	15	Yes	Yes	Yes	Yes									2
	n260	60	See CA_n260D Bandwidth Combination Fall-back Group 2 in Table 6.X.2-1											420	
		120												420	
DC_66A-n260E	66	15	Yes	Yes	Yes	Yes									
	n260	60	See CA_n260E Bandwidth Combination Fall-back Group 2 in Table 6.X.2-1											620	
		120												620	
DC_66A-n260F	66	15	Yes	Yes	Yes	Yes									
	n260	60	See CA_n260F Bandwidth Combination Fall-back Group 2 in Table 6.X.2-1											820	
		120												820	
DC_66A-n260G	66	15	Yes	Yes	Yes	Yes									3
	n260	60	See CA_n260G Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2											220	
		120												220	
DC_66A-n260H	66	15	Yes	Yes	Yes	Yes									
	n260	60	See CA_n260H Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2											320	
		120												320	
DC_66A-n260I	66	15	Yes	Yes	Yes	Yes									
	n260	60	See CA_n260I Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2											420	
		120												420	
DC_66A-n260J	66	15	Yes	Yes	Yes	Yes									
	n260	60	See CA_n260J Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2											520	
		120												520	
DC_66A-n260K	66	15	Yes	Yes	Yes	Yes									
	n260	60	See CA_n260K Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2											620	
		120												620	
DC_66A-n260L	66	15	Yes	Yes	Yes	Yes									

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	n260	60	See CA_n260L Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2												720	
		120													720	
DC_66A-n260M	66	15	Yes	Yes	Yes	Yes									820	
	n260	60	See CA_n260M Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2													
		120													820	
DC_66A-n260O	66	15	Yes	Yes	Yes	Yes									220	4
	n260	60	See CA_n260O Bandwidth Combination Fall-back Group 4 in Table 6.X.2-1													
		120													220	
DC_66A-n260P	66	15	Yes	Yes	Yes	Yes									320	
	n260	60	See CA_n260P Bandwidth Combination Fall-back Group 4 in Table 6.X.2-1													
		120													320	
DC_66A-n260Q	66	15	Yes	Yes	Yes	Yes									420	
	n260	60	See CA_n260Q Bandwidth Combination Fall-back Group 4 in Table 6.X.2-1													
		120													420	

Table 6.85.2-2: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and 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]
DC_66A-n260(2A)	66	15	Yes	Yes	Yes	Yes								420
	n260	60	See CA_n260(2A) Bandwidth Combination in **Table 8.9.2-1**											
		120												820
DC_66A-n260(3A)	66	15	Yes	Yes	Yes	Yes								620
	n260	60	See CA_n260(3A) Bandwidth Combination in **Table 8.9.2-1**											
		120												1220
DC_66A-n260(4A)	66	15	Yes	Yes	Yes	Yes								820
	n260	60	See CA_n260(4A) Bandwidth Combination in **Table 8.9.2-1**											
		120												1620
DC_66A-n260(D-G)	66	15	Yes	Yes	Yes	Yes								620
	n260	60	See CA_n260(D-G) Bandwidth Combination in **Table 8.9.2-2**											
		120												620
DC_66A-n260(D-H)	66	15	Yes	Yes	Yes	Yes								720
	n260	60	See CA_n260(D-H) Bandwidth Combination in **Table 8.9.2-2**											
		120												720
DC_66A-n260(D-I)	66	15	Yes	Yes	Yes	Yes								820
	n260	60	See CA_n260(D-I) Bandwidth Combination in **Table 8.9.2-2**											
		120												820
DC_66A-n260(D-O)	66	15	Yes	Yes	Yes	Yes								620
	n260	60	See CA_n260(D-O) Bandwidth Combination in **Table 8.9.2-2**											
		120												620
DC_66A-n260(D-P)	66	15	Yes	Yes	Yes	Yes								720
	n260	60	See CA_n260(D-P) Bandwidth Combination in **Table 8.9.2-2**											
		120												720
DC_66A-n260(D-Q)	66	15	Yes	Yes	Yes	Yes								820
	n260	60	See CA_n260(D-Q) Bandwidth Combination in **Table 8.9.2-2**											
		120												820
DC_66A-n260(E-O)	66	15	Yes	Yes	Yes	Yes								820
	n260	60	See CA_n260(E-O) Bandwidth Combination in **Table 8.9.2-2**											
		120												820
DC_66A-n260(E-P)	66	15	Yes	Yes	Yes	Yes								920

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	n260	60	See CA_n260(E-P) Bandwidth Combination in **Table 8.9.2-2**											
		120												920
DC_66A-n260(E-Q)	66	15	Yes	Yes	Yes	Yes								
	n260	60	See CA_n260(E-Q) Bandwidth Combination in **Table 8.9.2-2**											1020
		120												1020
DC_66A-n260(A-I)	66	15	Yes	Yes	Yes	Yes								820
	n260	60	See CA_n260(A-I) Bandwidth Combination in Table 5.5A.2-2 of TS 38.101-2											
		120												820
DC_66A-n260(G-I)	66	15	Yes	Yes	Yes	Yes								620
	n260	60	See CA_n260(G-I) Bandwidth Combination in Table 5.5A.2-2 of TS 38.101-2											
		120												620

6.85.3 Co-existence studies

Table 6.85.3-1 lists up to 7th harmonic and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 66+Band n260 2UL DC.

Table 6.85.3-1: Band 66 and Band n260 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1710	1780	37000	40000
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3420	3560	74000	80000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5130	5340	111000	120000
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	6840	7120	148000	160000
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	8550	8900	185000	200000
6th harmonics frequency limits	6*fx_low	6*fx_high	6* fy_low	6* fy_high
6th harmonics frequency limits (MHz)	10260	10680	222000	240000
7th harmonics frequency limits	7*fx_low	7*fx_high	7* fy_low	7* fy_high
7th harmonics frequency limits (MHz)	11970	12460	259000	280000
2nd order IMD products	|f2_low–f1_high|	|f2_high–f1_low|	|f2_low + f1_low|	|f2_high + f1_high|
IMD frequency limits (MHz)	35220	38290	38710	41780
3rd order IMD products	|f2_low–2*f1_high|	|f2_high–2*f1_low|	|2*f2_low–f1_high|	|2*f2_high – f1_low|
IMD frequency limits (MHz)	33440	36580	72220	78290
3rd order IMD products	|2*f1_low + f2_low|	|2*f1_high + f2_high|	|2*f2_low + f1_low|	|2*f2_high + f1_high|
IMD frequency limits (MHz)	40420	43560	75710	81780
4rd order IMD products	|3*f1_low – f2_high|	|3*f1_high – f2_low|	|3*f2_low–f1_high|	|3*f2_high –f1_low|
IMD frequency limits (MHz)	31660	34870	109220	118290
4rd order IMD products	|3*f1_low +f2_low|	|3*f1_high + f2_high|	|3*f2_low+f1_low|	|3*f2_high +f1_high|
IMD frequency limits (MHz)	42130	45340	112710	121780
4rd order IMD products	|2*f1_low-2*f2_high |	|2*f1_high –2*f2_low|	|2*f1_low+2*f2_low|	|2*f1_high +2*f2_high|
IMD frequency limits (MHz)	70440	76580	77420	83560
5rd order IMD products	|f1_low –4*f2_high |	|f1_high –4*f2_low|	|f2_low–4*f1_high|	|f2_high –4*f1_low|
IMD frequency limits (MHz)	146220	158290	29880	33160
5rd order IMD products	|f1_low +4*f2_low|	|f1_high +4*f2_high|	|f2_low+4*f1_low|	|f2_high +4*f1_high|
IMD frequency limits (MHz)	149710	161780	43840	47120
5rd order IMD products	|2*f1_low-3*f2_high|	|2*f1_high–3*f2_low|	|2*f2_low-3*f1_high|	|2*f2_high -3*f1_low|
IMD frequency limits (MHz)	107440	116580	68660	74870
5rd order IMD products	|2*f1_low +3*f2_low|	|2*f1_high +3*f2_high|	|2*f2_low+3*f1_low|	|2*f2_high +3*f1_high|
IMD frequency limits (MHz)	114420	123560	79130	85340

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Based on Table 6.85.3-1, it can be seen that

- 2nd order harmonics may fall into LTE frequencies of Band 22, 42, 48, n77, n78
- 3rd order harmonic may fall into LTE frequencies of Band 46
- 2nd order IMD products may fall into own Rx frequencies of band n260
- 3rd order IMD products may fall into Rx frequencies of Band 1, n1, 2, n2, 3, n3, 4, 9, 10, 11, 21, 23, 24, 25, 32, 33, 34, 35, 36, 37, 39, 45, 50, n50, 51, n51, 65, 66, n66, 70, n70, 74, n74, 75, n75, 76, n76, n80, n84

Therefore it can be concluded that there is no harmonic interference and IMD product falling into their own Rx bands.

When 2UL inter-band EN-DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.85.3-2 lists up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.85.3-2: Band 66 and Band n260 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		3rd IMD
Galileo	1559	-	1591	Yes		3rd IMD
GLONASS	1591	-	1610	Yes		3rd IMD
GPS	1563	-	1587	Yes		3rd IMD
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	Yes	US	3rd harmonic
	5150	-	5350	Yes	Europe	3rd harmonic
	5470	-	5725	No		
	5150	-	5825	Yes	Asia	3rd harmonic
45GHz Unlicensed Bands	42300	-	47000	Yes	China	3rd, 4th, 5th IMD
	47200	-	48400	No	China	
60GHz Unlicensed Bands	57000	-	66000	No	Europe	
	57050	-	64000	No	USA - Canada	
	57000	-	64000	No	South Korea	
	59000	-	66000	No	Japan	
	59000	-	64000	No	China	
	59400	-	62900	No	Australia	

Table 6.85.3-3 lists the protected bands required for the dual connectivity configuration.

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Table 6.85.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_66A_n260A	Bands 2, 4, 5, 12, 13, 14, 17, 24, 25, 26, 29, 30, 41, 48, 66, 70, 71, n71, n257	F_{DL_low}	-	F_{DL_high}	-50	1	
	Bands 48	F_{DL_low}	-	F_{DL_high}	-50	1	3

NOTE 1: F_{DL_low} and F_{DL_high} refer to each E-UTRA frequency band specified in Table 5.5-1of TS 36.101 [2].
NOTE 2: F_{DL_low} and F_{DL_high} refer to each NR frequency band specified in Table 5.2-1 of TS 38.101-1 [3] and 38.101-2 [4].
NOTE 3: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.6.3.1-2 of TS 36.101 [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.

6.85.4 ΔT_{IB} and ΔR_{IB} values

For DC_66A_n260, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are given in the tables below.

Table 6.85.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_66A_n260	66	0
	n260	0

Table 6.85.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
DC_66A_n260	66	0
	n260	0

6.85.5 REFSENs requirements

There is no specific REFSENs requirement.

6.86 DC_2_n257

6.86.1 Operating bands for DC

Table 6.86.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_2_n257	2	1850 MHz – 1910 MHz	1930 MHz – 1990 MHz	FDD
	n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD

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6.86.2 Channel bandwidths per operating band for DC

Table 6.86.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	**E-UTRA and 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]**
DC_2A_n257A	2	15	Yes	Yes	Yes	Yes								220
	n257	60						Yes			Yes	Yes		
		120						Yes			Yes	Yes	Yes	420

Table 6.86.2-2: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band (non-contiguous)

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	**E-UTRA and 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]**
DC_2A_n257(2A)	2	15	Yes	Yes	Yes	Yes								420
	n257	60	See CA_n257(2A) CA bandwidth combinations in TS 38.101-2 [4].											
		120												820

6.86.3 Co-existence studies

Table 6.86.3-1 lists Band 2A +Band n257A 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.86.3-1: Band 2 and Band n257 UL harmonics and IMD products

UE UL carriers	**fx_low**	**fx_high**	**fy_low**	**fy_high**
UL frequency (MHz)	1850	1910	26500	29500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3700	3820	53000	59000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5550	5730	79500	88500
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	27650	24590	28350	31410
Two-tone 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)	25800	22680	51090	57150
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)	30200	33320	54850	60910
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)	1450	2310	26480	29520
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|

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IMD frequency limits (MHz)	55300	49180	56700	62820
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)	23950	20770	77590	86650
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)	32050	35230	81350	90410
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)	116150	104090	18860	22100
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)	107850	119910	33900	37140
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)	84800	75680	47270	53450
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)	83200	92320	58550	64730

Based on Table **6.86.3-1**

- 2nd order harmonics may fall into LTE frequencies of Band 43
- 3rd order harmonic may fall into LTE frequencies of Band 46
- 2nd order IMD products may fall into Rx frequencies of band n257 and n258
- 3rd order IMD products may fall into Rx frequencies of Band 1, 3, 4, 9, 10, 11, 21, 23, 24, 25, 32, 33, 34, 35, 36, 37, 39, 40, 45, 50, 65, 66, 70, 74,75 and band n257, n258
- 3rd order IMD products may fall into own Rx frequencies of Band 2 and n257
- 5th order IMD products may fall into Rx frequencies of band n260

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.X.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.86.3-2: 2UL Band 2 +Band n257 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	YES		IMD3
Galileo	1559	-	1591	YES		IMD3
GLONASS	1591	-	1610	YES		IMD3
GPS	1563	-	1587	YES		IMD3
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	YES	US	3rd order harmonic
	5150	-	5350	No	Europe	
	5470	-	5725	YES		3rd order harmonic
	5150	-	5825	YES	Asia	3rd order harmonic
45GHz Unlicensed Bands	42300	-	47000	No	China	
	47200	-	48400	YES	China	5th IMD
60GHz Unlicensed Bands	57000	-	66000	YES	Europe	2nd order harmonic 3rd, 4th, 5th IMD
	57050	-	64000	YES	USA - Canada	2nd order harmonic 3rd, 4th, 5th IMD
	57000	-	64000	YES	South Korea	2nd order harmonic 3rd, 4th, 5th IMD
	59000	-	66000	YES	Japan	3rd, 4th, 5th IMD
	59000	-	64000	YES	China	3rd, 4th, 5th IMD
	59400	-	62900	YES	Australia	3rd, 4th, 5th IMD

Table 6.86.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.86.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_2A_-n257	Band 4, 5, 10, 12, 13, 14, 17, 24, 26, 27, 28, 29, 30, 41, 42, 48, 50, 51, 66, 70, 71, 74, 74, n77, n78	F_{DL_low}	-	F_{DL_high}	-50	1	
	Band 2, 25	F_{DL_low}	-	F_{DL_high}	-50	1	2
	Band 43	F_{DL_low}	-	F_{DL_high}	-50	1	1
NOTE 1; Table 6.5.3.2-1 of TS38.101 NOTE 2: NOTE 15 in Table 6.6.3.2-1 of 36.101 [2] will be applied here. Additional requirements for the frequency ranges that are less than FOOB (MHz) in Table 6.86.3.1-1 need further study.							

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6.86.4 ΔT_{IB} and ΔR_{IB} values

For DC_2-n257, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.86.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_2_n257	2	0
	n257	0

Table 6.86.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_2_n257	2	0
	n257	0

6.86.5 MSD

No IMD issues are expected for DC configuration between the LTE bands below 6GHz and FR2 NR band. Furthermore, up to 7th order harmonics have no impact to Rx frequency of both LTE and NR bands.

6.87 DC_13A-n257A

6.87.1 Operating bands for DC

Table 6.87.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_13A-n257A	13	777 MHz – 787 MHz	746 MHz – 756 MHz	FDD
	n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD

6.87.2 Channel bandwidths per operating band for DC

Table 6.87.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and 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]
DC_13A-n257A	13	15	Yes	Yes										210
	n257	60						Yes			Yes	Yes		
		120						Yes			Yes	Yes	Yes	410

6.87.3 Co-existence studies

Table 6.87.3-1 lists Band 13A +Band n257A 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.87.3-1: Band 13 and Band n257 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	777	787	26500	29500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1554	1574	53000	59000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2331	2361	79500	88500
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	28723	25713	27277	30287
Two-tone 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)	27946	24926	52213	58223
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)	28054	31074	53777	59787
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)	377	1187	26490	29510
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)	-57446	-51426	54554	60574
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)	-27169	-24139	78713	87723
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)	28831	31861	80277	89287
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)	-117223	-105213	23352	26392
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)	106777	118787	29608	32648
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)	-86946	-77926	50639	56669
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)	81054	90074	55331	61361

Based on Table **6.87.3-1**

- 2nd order harmonics may fall into frequencies of band 24
- 3rd order harmonic may fall into frequencies of band 30 and 40
- 2nd order IMD products may fall into Rx frequencies of band n257 and n258
- 3rd order IMD products may fall into Rx frequencies of Band 5, 6, 8, 12, 13, 14, 17, 18, 19, 20, 26, 27, 28, 29, 31, 44, 67, 68, 71, 72, 73 and band n258
- 3rd order IMD products may fall into own Rx frequencies of Band 13 and band n257
- 4th order IMD products may fall into Rx frequencies of band n257 and n258
- 5th order IMD products may fall into Rx frequencies of band n258

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When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.87.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.87.3-2: 2UL Band 13 +Band n257 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	YES		2nd harmonics
Galileo	1559	-	1591	YES		2nd harmonics
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	YES		2nd harmonics
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	
45GHz Unlicensed Bands	42300	-	47000	No	China	
	47200	-	48400	YES	China	5th IMD
60GHz Unlicensed Bands	57000	-	66000	YES	Europe	2nd order harmonic 3rd, 4th, 5th IMD
	57050	-	64000	YES	USA - Canada	2nd order harmonic 3rd, 4th, 5th IMD
	57000	-	64000	YES	South Korea	2nd order harmonic 3rd, 4th, 5th IMD
	59000	-	66000	YES	Japan	3rd, 4th, 5th IMD
	59000	-	64000	YES	China	3rd, 4th, 5th IMD
	59400	-	62900	YES	Australia	3rd, 4th, 5th IMD

Table 6.87.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.87.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_13A-n257A	Band 2, 4, 5, 10, 12, 13, 17, 25, 26, 27, 29, 41, 48, 50, 51, 66, 70, 71, 74, n77, n78	F_{DL_low}	-	F_{DL_high}	-50	1	
	Band 14	F_{DL_low}	-	F_{DL_high}	-50	1	2
	Band 24, 30	F_{DL_low}	-	F_{DL_high}	-50	1	1
NOTE 1: Table 6.5.3.2-1 of TS38.101 NOTE 2: NOTE 15 in Table 6.6.3.2-1 of 36.101 [2] will be applied here. Additional requirements for the frequency ranges that are less than FOOB (MHz) in Table 6.87.3.1-1 need further study.							

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6.87.4 ΔT_{IB} and ΔR_{IB} values

For DC_13A-n257A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.87.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_13A-n257A	13	0
	n257	0

Table 6.87.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_13A-n257A	13	0
	n257	0

6.87.5 MSD

No IMD issues are expected for DC configuration between the LTE bands below 6GHz and FR2 NR band. Furthermore, up to 7th order harmonics have no impact to Rx frequency of both LTE and NR bands.

6.88 DC_48A-n257A

6.88.1 Operating bands for DC

Table 6.88.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_48A-n257A	48	3550 MHz – 3700 MHz	3550 MHz – 3700 MHz	TDD
	n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD

6.88.2 Channel bandwidths per operating band for DC

Table 6.88.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and 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]
DC_48A-n257A	48	15	Yes	Yes	Yes	Yes								220
	n257	60						Yes			Yes	Yes		
		120						Yes			Yes	Yes	Yes	420

6.88.3 Co-existence studies

Table 6.88.3-1 lists Band 48A +Band n257A 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

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Table 6.88.3-1: Band 48 and Band n257 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	3550	3700	26500	29500
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	7100	7400	53000	59000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	10650	11100	79500	88500
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	25950	22800	30050	33200
Two-tone 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)	22400	19100	49300	55450
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)	33600	36900	56550	62700
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)	3150	4100	26480	29520
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)	51900	45600	60100	66400
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)	18850	15400	75800	84950
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)	37150	40600	83050	92200
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)	114450	102300	11700	15300
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)	109550	121700	40700	44300
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)	81400	72100	41900	48350
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)	86600	95900	63650	70100

Based on Table **6.88.3-1**

- 2nd order IMD products may fall into frequencies of band n258
- 3rd order IMD products may fall into frequencies of band 22, 42, 43 and 48
- 3rd order IMD products may fall into own Rx frequencies of band n257 and n258
- 4th order IMD products may fall into frequencies of band n260

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.88.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.88.3-2: 2UL Band 48 +Band n257 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	

Table 6.88.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.88.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_48A-n257A	Band 2, 4, 5, 12, 13, 14, 17, 24, 25, 26, 29, 30, 41, 50, 51, 66, 70, 71, 74	F_{DL_low}	-	F_{DL_high}	-50	1	

6.88.4 ΔT_{IB} and ΔR_{IB} values

For DC_48A-n257A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.88.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_48A-n257A	48	0
	n257	0

Table 6.88.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_48A-n257A	48	0
	n257	0

6.88.5 MSD

No IMD issues are expected for DC configuration between the LTE bands below 6GHz and FR2 NR band. Furthermore, up to 7th order harmonics have no impact to Rx frequency of both LTE and NR bands.

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6.89 DC_5A-n260

6.89.1 Operating bands for DC

Table 6.89.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_5A-n260	5	824 MHz – 849 MHz	869 MHz – 894 MHz	FDD
	n260	37000 MHz – 40000 MHz	37000 MHz – 40000 MHz	TDD

6.89.2 Channel bandwidths per operating band for DC

Table 6.89.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and 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]	Fallback Group
DC_5A-n260A	5	15	Yes	Yes											
	n260	60						Yes			Yes	Yes		210	
		120						Yes			Yes	Yes	Yes	410	
DC_5A-n260B	5	15	Yes	Yes											1
	n260	60	See NR CA_n260B Bandwidth Combination Fall-back Group 1 in Table 6.X.2-1												
		120												810	
DC_5A-n260C	5	15	Yes	Yes											
	n260	60	See NR CA_n260C Bandwidth Combination Fall-back Group 1 in Table 6.X.2-1												
		120												1210	
DC_5A-n260D	5	15	Yes	Yes											2
	n260	60	See NR CA_n260D Bandwidth Combination Fall-back Group 2 in Table 6.X.2-1											410	
		120												410	
DC_5A-n260E	5	15	Yes	Yes											
	n260	60	See NR CA_n260E Bandwidth Combination Fall-back Group 2 in Table 6.X.2-1											610	
		120												610	
DC_5A-n260F	5	15	Yes	Yes											
	n260	60	See NR CA_n260F Bandwidth Combination Fall-back Group 2 in Table 6.X.2-1											810	
		120												810	
DC_5A-n260G	5	15	Yes	Yes											3
	n260	60	See NR CA_n260G Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2											210	
		120												210	
DC_5A-n260H	5	15	Yes	Yes											
	n260	60	See NR CA_n260H Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2											310	
		120												310	
DC_5A-n260I	5	15	Yes	Yes											
	n260	60	See NR CA_n260I Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2											410	
		120												410	
DC_5A-n260J	5	15	Yes	Yes											
	n260	60	See NR CA_n260J Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2											510	
		120												510	
DC_5A-n260K	5	15	Yes	Yes											
	n260	60	See NR CA_n260K Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2											610	
		120												610	
	5	15	Yes	Yes											

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DC_5A-n260L	n260	60	See NR CA_n260L Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2														710	
		120															710	
DC_5A-n260M	5	15	Yes	Yes													810	
	n260	60	See NR CA_n260M Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2															
		120															810	
DC_5A-n260O	5	15	Yes	Yes													210	
	n260	60	See NR CA_n260O Bandwidth Combination Fall-back Group 4 in Table 6.X.2-2															
		120															210	
DC_5A-n260P	5	15	Yes	Yes													310	4
	n260	60	See NR CA_n260P Bandwidth Combination Fall-back Group 4 in Table 6.X.2-2															
		120															310	
DC_5A-n260Q	5	15	Yes	Yes													410	
	n260	60	See NR CA_n260Q Bandwidth Combination Fall-back Group 4 in Table 6.X.2-2															
		120															410	

Table 6.89.2-2: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and 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]
DC_5A-n260(2A)	5	15	Yes	Yes										
	n260	60	See NR CA_n260 (2A) Bandwidth Combination in **Table 8.9.2-1**											410
		120												810
DC_5A-n260(3A)	5	15	Yes	Yes										
	n260	60	See NR CA_n260(3A) Bandwidth Combination in **Table 8.9.2-1**											610
		120												1210
DC_5A-n260(4A)	5	15	Yes	Yes										810
	n260	60	See NR CA_n260(4A) Bandwidth Combination in **Table 8.9.2-1**											
		120												1610
DC_5A-n260(D-G)	5	15	Yes	Yes										
	n260	60	See CA_n260(D-G) Bandwidth Combination in **Table 8.9.2-2**											610
		120												610
DC_5A-n260(D-H)	5	15	Yes	Yes										
	n260	60	See CA_n260(D-H) Bandwidth Combination in **Table 8.9.2-2**											710
		120												710
DC_5A-n260(D-I)	5	15	Yes	Yes										
	n260	60	See CA_n260(D-I) Bandwidth Combination in **Table 8.9.2-2**											810
		120												810
DC_5A-n260(D-O)	5	15	Yes	Yes										
	n260	60	See NR CA_n260(D-O) Bandwidth Combination in **Table 8.9.2-2**											610
		120												610
DC_5A-n260(D-P)	5	15	Yes	Yes										
	n260	60	See NR CA_ n260(D-P) Bandwidth Combination in **Table 8.9.2-2**											710
		120												710
DC_5A-n260(D-Q)	5	15	Yes	Yes										
	n260	60	See NR CA_ n260(D-Q) Bandwidth Combination in **Table 8.9.2-2**											810
		120												810
DC_5A-n260(E-O)	5	15	Yes	Yes										
	n260	60	See NR CA_n260(E-O) Bandwidth Combination in **Table 8.9.2-2**2											810
		120												810
DC_5A-n260(E-P)	5	15	Yes	Yes										
	n260	60	See NR CA_n260(E-P) Bandwidth Combination in **Table 8.9.2-2**											910
		120												910
DC_5A-n260(E-Q)	5	15	Yes	Yes										

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	n260	60	See NR CA_n260(E-Q) Bandwidth Combination in **Table 8.9.2-2**											1010
		120												1010
DC_5A-n260(A-I)	5	15	Yes	Yes										810
	n260	60	See CA_n260(A-I) Bandwidth Combination in Table 5.5A.2-2 of TS 38.101-2											
		120												810
DC_5A-n260(G-I)	5	15	Yes	Yes										610
	n260	60	See CA_n260(G-I) Bandwidth Combination in Table 5.5A.2-2 of TS 38.101-2											
		120												610

6.89.3 Co-existence studies

Table 6.89.3-1 lists Band 5A +Band n260A 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.89.3-1: Band 5 and Band n260 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	824	849	37000	40000
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1648	1698	74000	80000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2472	2547	111000	120000
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	39176	36151	37824	40849
Two-tone 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)	38352	35302	73151	79176
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)	38648	41698	74824	80849
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)	424	1249	36990	40010
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)	78352	72302	75648	81698
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)	37528	34453	110151	119176
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)	159176	147151	33604	36704
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_high|	|2*fx_high – 3*fy_low|	|2*fy_low – 3*fx_high|	|2*fy_high – 3*fx_low|
IMD frequency limits (MHz)	118352	109302	71453	77528
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

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Based on Table **6.89.3-1**

- 3rd order harmonic may fall into frequencies of band 41, n41
- 2nd order IMD products may fall into own Rx frequencies of band n260
- 3rd order IMD products may fall into own Rx frequencies of band n260
- 3rd order IMD products may fall into frequencies of band 5, n5,6, 8, n8, 12, n12, 13, n13, 14, 17, 18, 19, 20, n20, 26, 27, 28, n28, 29, 31, 44, 67, 68, 71, n71, 72, 73, n81, n82 and n83
- 4th order IMD products may fall into own Rx frequencies of band n260

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.89.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.89.3-2: 2UL Band 5 +Band n260 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	YES	US/Europe	3rd order harmonic
	2400	-	2494	YES	Asia	3rd order harmonic
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	

Table 6.89.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.89.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_5A-n260A	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, 50, 51, 65, 66, 70, 71, 74, n77, n78	F_{DL_low}	-	F_{DL_high}	-50	1	
	Band 26	F_{DL_low}	-	F_{DL_high}	-27	1	
	Band 41	F_{DL_low}	-	F_{DL_high}	-50	1	1
NOTE 1: Table 6.5.3.2-1 of TS38.101							

6.89.4 ΔT_{IB} and ΔR_{IB} values

For DC_5A-n260A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

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Table 6.89.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_5A-n260A	5	0
	n260	0

Table 6.89.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_5A-n260A	5	0
	n260	0

6.89.5 MSD

No IMD issues are expected for DC configuration between the LTE bands below 6GHz and FR2 NR band. Furthermore, up to 7th order harmonics have no impact to Rx frequency of both LTE and NR bands.

6.90 DC_13A-n260A

6.90.1 Operating bands for DC

Table 6.90.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band	Downlink (DL) band	Duplex mode
		BS receive / UE transmit	BS transmit / UE receive	
		$F_{UL\_low} - F_{UL\_high}$	$F_{DL\_low} - F_{DL\_high}$	
DC_13A-n260A	13	777 MHz – 787 MHz	746 MHz – 756 MHz	FDD
	n260	37000 MHz – 40000 MHz	37000 MHz – 40000 MHz	TDD

6.90.2 Channel bandwidths per operating band for DC

Table 6.90.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and 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]
DC_13A-n260A	13	15	Yes	Yes										210
	n260	60						Yes			Yes	Yes		
		120						Yes			Yes	Yes	Yes	410

6.90.3 Co-existence studies

Table 6.90.3-1 lists Band 13A +Band n260A 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.90.3-1: Band 13 and Band n260 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high

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UL frequency (MHz)	777	787	37000	40000
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1554	1574	74000	80000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2331	2361	111000	120000
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	39223	36213	37777	40787
Two-tone 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)	38446	35426	73213	79223
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)	38554	41574	74777	80787
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)	377	1187	36990	40010
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)	78446	72426	75554	81574
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)	37669	34639	110213	119223
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)	39331	42361	111777	120787
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)	159223	147213	33852	36892
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)	148777	160787	40108	43148
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)	118446	109426	71639	77669
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)	112554	121574	76331	82361

Based on Table **6.90.3-1**

- 2nd order harmonics may fall into LTE frequencies of Band 24
- 3rd order harmonic may fall into LTE frequencies of Band 30 and 40
- 2nd order IMD products may fall into own Rx frequencies of band n260
- 3rd order IMD products may fall into own Rx frequencies of band n260
- 3rd order IMD products may fall into Rx frequencies of Band 5, 6, 8, 12, 13, 14, 17, 18, 19, 20, 26, 27, 28, 29, 31, 44, 67, 68, 71 and 72
- 4th order IMD products may fall into own Rx frequencies of band n260

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.90.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.90.3-2: 2UL Band 13 +Band n260 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	YES		2nd harmonics
Galileo	1559	-	1591	YES		2nd harmonics
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	YES		2nd harmonics
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	
45GHz Unlicensed Bands	42300	-	47000	YES	China	4th, 5th IMD
	47200	-	48400	No	China	
60GHz Unlicensed Bands	57000	-	66000	No	Europe	
	57050	-	64000	No	USA - Canada	
	57000	-	64000	No	South Korea	
	59000	-	66000	No	Japan	
	59000	-	64000	No	China	
	59400	-	62900	No	Australia	

Table 6.90.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.90.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_13A-n260A	E-UTRA Band 2, 4, 5, 10, 12, 13, 17, 25, 26, 27, 29, 41, 48, 50, 51, 66, 70, 71, 74, n77, n78	F_{DL_low}	-	F_{DL_high}	-50	1	
	Band 14	F_{DL_low}	-	F_{DL_high}	-50	1	2
	Band 24, 30	F_{DL_low}	-	F_{DL_high}	-50	1	1
NOTE 1: Table 6.5.3.2-1 of TS38.101 NOTE 2: NOTE 15 in Table 6.6.3.2-1 of 36.101 [2] will be applied here. Additional requirements for the frequency ranges that are less than FOOB (MHz) in Table 6.90.3.1-1 need further study.							

6.90.4 ΔT_{IB} and ΔR_{IB} values

For DC_13A-n260A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

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Table 6.90.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_13A-n260A	13	0
	n260	0

Table 6.90.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_13A-n260A	13	0
	n260	0

6.90.5 MSD

No IMD issues are expected for DC configuration between the LTE bands below 6GHz and FR2 NR band. Furthermore, up to 7th order harmonics have no impact to Rx frequency of both LTE and NR bands.

6.91 DC_48A-n260A

6.91.1 Operating bands for DC

Table 6.91.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_48A-n260A	48	3550 MHz – 3700 MHz	3550 MHz – 3700 MHz	TDD
	n260	37000 MHz – 40000 MHz	37000 MHz – 40000 MHz	TDD

6.91.2 Channel bandwidths per operating band for DC

Table 6.91.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and 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]
DC_48A-n260A	48	15	Yes	Yes	Yes	Yes								220
	n260	60						Yes			Yes	Yes		
		120						Yes			Yes	Yes	Yes	420

6.91.3 Co-existence studies

Table 6.91.3-1 lists Band 48A +Band n260A 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.91.3-1: Band 48 and Band n260 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high

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UL frequency (MHz)	3550	3700	37000	40000
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	7100	7400	74000	80000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	10650	11100	111000	120000
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	36450	33300	40550	43700
Two-tone 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)	32900	29600	70300	76450
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)	44100	47400	77550	83700
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)	3150	4100	36980	40020
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)	-72900	-66600	81100	87400
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)	-29350	-25900	107300	116450
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)	47650	51100	114550	123700
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)	-156450	-144300	22200	25800
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)	151550	163700	51200	54800
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)	-112900	-103600	62900	69350
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)	118100	127400	84650	91100

Based on Table **6.91.3-1**

- 3rd order IMD products may fall into frequencies of Band 22, 42, 43, 76 and n260
- 4th order IMD products may fall into frequencies of band n257 and n258
- 5th order IMD products may fall into frequencies of band n258

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.91.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.91.3-2: 2UL Band 48 +Band n260 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	

Table 6.91.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.91.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_48A-n260A	Band 2, 4, 5, 12, 13, 14, 17, 24, 25, 26, 29, 30, 41, 50, 51, 66, 70, 71, 74	F_{DL_low}	-	F_{DL_high}	-50	1	

6.91.4 ΔT_{IB} and ΔR_{IB} values

For DC_48A-n260A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.91.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_48A-n260A	48	0
	n260	0

Table 6.91.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_48A-n260A	48	0
	n260	0

6.91.5 MSD

No IMD issues are expected for DC configuration between the LTE bands below 6GHz and FR2 NR band. Furthermore, up to 7th order harmonics have no impact to Rx frequency of both LTE and NR bands.

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6.92 DC_5A-n261

6.92.1 Operating bands for DC

Table 6.92.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band BS receive / UE transmit F_{UL_low} – F_{UL_high}	Downlink (DL) band BS transmit / UE receive F_{DL_low} – F_{DL_high}	Duplex mode
DC_5A-n261	5	824 MHz – 849 MHz	869 MHz – 894 MHz	FDD
	n261	27500 MHz – 28350 MHz	27500 MHz – 28350 MHz	TDD

6.92.2 Channel bandwidths per operating band for DC

Table 6.92.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and 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]	Fallback Group
DC_5A-n261B	5	15	Yes	Yes											1
	n261	60	See NR CA_n261B Bandwidth Combination Fall-back Group 1 in Table 6.X.2-1												
		120												810	
DC_5A-n261C	5	15	Yes	Yes											
	n261	60	See NR CA_n261C Bandwidth Combination Fall-back Group 1 in Table 6.X.2-1												
		120												810*	
DC_5A-n261D	5	15	Yes	Yes											2
	n261	60	See NR CA_n261D Bandwidth Combination Fall-back Group 2 in Table 6.X.2-1											410	
		120												410	
DC_5A-n261E	5	15	Yes	Yes											
	n261	60	See NR CA_n261E Bandwidth Combination Fall-back Group 2 in Table 6.X.2-1											610	
		120												610	
DC_5A-n261F	5	15	Yes	Yes											
	n261	60	See NR CA_n261F Bandwidth Combination Fall-back Group 2 in Table 6.X.2-1											810	
		120												810	
DC_5A-n261G	5	15	Yes	Yes											3
	n261	60	See NR CA_n261G Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2											210	
		120												210	
DC_5A-n261H	5	15	Yes	Yes											
	n261	60	See NR CA_n261H Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2											310	
		120												310	
DC_5A-n261I	5	15	Yes	Yes											
	n261	60	See NR CA_n261I Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2											410	
		120												410	
DC_5A-n261J	5	15	Yes	Yes											
	n261	60	See NR CA_n261J Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2											510	
		120												510	
DC_5A-n261K	5	15	Yes	Yes											
	n261	60	See NR CA_n261K Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2											610	
		120												610	
DC_5A-n261L	5	15	Yes	Yes											
	n261	60	See NR CA_n261L Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2											710	
		120												710	
DC_5A-n261M	5	15	Yes	Yes											
	n261	60	See NR CA_n261M Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2											810	
		120												810	

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DC_5A-n261O	5	15	Yes	Yes										210	4
	n261	60	See NR CA_n261O Bandwidth Combination Fall-back Group 4 in Table 6.X.2-1												
		120												210	
DC_5A-n261P	5	15	Yes	Yes										310	
	n261	60	See NR CA_n261P Bandwidth Combination Fall-back Group 4 in Table 6.X.2-1												
		120												310	
DC_5A-n261Q	5	15	Yes	Yes										210	
	n261	60	See NR CA_n261Q Bandwidth Combination Fall-back Group 4 in Table 6.X.2-1												
		120												210	

Note*: The maximum bandwidth of band n261 is 850MHz.

Table 6.92.2-2: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and 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]
DC_5A-n261(2A)	5	15	Yes	Yes										
	n261	60	See CA_ n261(2A) Bandwidth Combination in **Table 8.10.2-1**											610
		120												810*
DC_5A-n261(3A)	5	15	Yes	Yes										
	n261	60	See NR CA_ n261(3A) Bandwidth Combination in **Table 8.10.2-1**											610
		120												810*
DC_5A-n261(4A)	5	15	Yes	Yes										
	n261	60	See NR CA_ n261(4A) Bandwidth Combination in **Table 8.10.2-1**											810
		120												810*
DC_5A-n261(D-G)	5	15	Yes	Yes										
	n261	60	See NR CA_ n261(D-G) Bandwidth Combination in **Table 8.10.2-2**											610
		120												610
DC_5A-n261(D-H)	5	15	Yes	Yes										
	n261	60	See NR CA_ n261(D-H) Bandwidth Combination in **Table 8.10.2-2**											710
		120												710
DC_5A-n261(D-I)	5	15	Yes	Yes										
	n261	60	See NR CA_ n261(D-I) Bandwidth Combination in **Table 8.10.2-2**											810
		120												810
DC_5A-n261(D-O)	5	15	Yes	Yes										
	n261	60	See NR CA_ n261(D-O) Bandwidth Combination in **Table 8.10.2-2**											610
		120												610
DC_5A-n261(D-P)	5	15	Yes	Yes										
	n261	60	See NR CA_ n261(D-P) Bandwidth Combination in **Table 8.10.2-2**											710
		120												710
DC_5A-n261(D-Q)	5	15	Yes	Yes										
	n261	60	See NR CA_ n261(D-Q) Bandwidth Combination in **Table 8.10.2-2**											810
		120												810
DC_5A-n261(E-O)	5	15	Yes	Yes										
	n261	60	See NR CA_n261(E-O) Bandwidth Combination in **Table 8.10.2-2**											810
		120												810
DC_5A-n261(E-P)	5	15	Yes	Yes										
	n261	60	See NR CA_n261(E-P) Bandwidth Combination in **Table 8.10.2-2**											810*
		120												810*
DC_5A-n261(E-Q)	5	15	Yes	Yes										
	n261	60	See NR CA_n261(E-Q) Bandwidth Combination in **Table 8.10.2-2**											810*
		120												810*

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6.92.3 Co-existence studies

Table 6.92.3-1 lists Band 66A+Band n261A 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.92.3-1: Band 5 and Band n261 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	824	849	27500	28350
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1648	1698	55000	56700
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2472	2547	82500	85050
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	27526	26651	28324	29199
Two-tone 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)	26702	25802	54151	55876
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)	29148	30048	55824	57549
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)	424	1249	27490	28360
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)	55052	53302	56648	58398
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)	25878	24953	81651	84226
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)	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)	112576	109151	24104	25054
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_high|	|2*fx_high – 3*fy_low|	|2*fy_low – 3*fx_high|	|2*fy_high – 3*fx_low|
IMD frequency limits (MHz)	83402	80802	52453	54228
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

Based on Table **6.92.3-1**

- 3rd order harmonic may fall into frequencies of band n41
- 2nd order IMD products may fall into own Rx frequencies of band n257, n258 and n261
- 3rd order IMD products may fall into Rx frequencies of Band 5, n5, 6, 8, 12, n12, 13, n13, 14, 17, 18, 19, 20, n20, 26, 27 , 28, n28, 29, 31, 44, 67, 68, 71, n71, 72, 73, n81, n82 and n83
- 3rd order IMD products may fall into Rx frequencies of band n257 and n258

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- 4th order IMD products may fall into Rx frequencies of band n258
- 5th order IMD products may fall into Rx frequencies of band n258

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.92.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.92.3-2: 2UL Band 5 +Band n261 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	YES	US/Europe	3rd order harmonic
	2400	-	2494	YES	Asia	3rd order harmonic
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	
45GHz Unlicensed Bands	42300	-	47000	No	China	
	47200	-	48400	No	China	
60GHz Unlicensed Bands	57000	-	66000	YES	Europe	3rd, 4th, 5th IMD
	57050	-	64000	YES	USA - Canada	3rd, 4th, 5th IMD
	57000	-	64000	YES	South Korea	3rd, 4th, 5th IMD
	59000	-	66000	YES	Japan	5th IMD
	59000	-	64000	YES	China	5th IMD
	59400	-	62900	No	Australia	

Table 6.92.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.92.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_5A-n261A	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, 50, 51, 65, 66, 70, 71, 74, n77, n78	F_{DL_low}	-	F_{DL_high}	-50	1	
	26	F_{DL_low}	-	F_{DL_high}	-27	1	
	41	F_{DL_low}	-	F_{DL_high}	-50	1	1
NOTE 1: Table 6.5.3.2-1 of TS38.101							

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6.92.4 ΔT_{IB} and ΔR_{IB} values

For DC_5A-n261A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.92.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_5A-n261A	5	0
	n261	0

Table 6.92.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_5A-n261A	5	0
	n261	0

6.92.5 MSD

No IMD issues are expected for DC configuration between the LTE bands below 6GHz and FR2 NR band. Furthermore, up to 7th order harmonics have no impact to Rx frequency of both LTE and NR bands.

6.93 DC_66A-n261

6.93.1 Operating bands for DC

Table 6.93.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_66A-n261	66	1710 MHz – 1780 MHz	2110 MHz – 2220 MHz	FDD
	n261	27500 MHz – 28350 MHz	27500 MHz – 28350 MHz	TDD

6.93.2 Channel bandwidths per operating band for DC

Table 6.93.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and 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]	Fallback Group
DC_66A-n261B	66	15	Yes	Yes	Yes	Yes									1
	n261	60	See CA_n261B Bandwidth Combination Fall-back Group 1 in Table 6.X.2-1												
		120												820	
DC_66A-n261C	66	15	Yes	Yes	Yes	Yes									
	n261	60	See CA_n261C Bandwidth Combination Fall-back Group 1 in Table 6.X.2-1												
		120												1220	
DC_66A-n261D	66	15	Yes	Yes	Yes	Yes									
	n261	60	See CA_n261D Bandwidth Combination Fall-back Group 2 in Table 6.X.2-1											420	
		120												420	
DC_66A-	66	15	Yes	Yes	Yes	Yes									
	n261	60	See CA_n261E Bandwidth Combination Fall-back Group 2 in Table 6.X.2-1											620	

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n261E		120												620	2
DC_66A-n261F	66	15	Yes	Yes	Yes	Yes								820	
	n261	60	See CA_n261F Bandwidth Combination Fall-back Group 2 in Table 6.X.2-1												
		120												820	
DC_66A-n261G	66	15	Yes	Yes	Yes	Yes								220	3
	n261	60	See CA_n261G Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2												
		120												220	
DC_66A-n261H	66	15	Yes	Yes	Yes	Yes								320	
	n261	60	See CA_n261H Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2												
		120												320	
DC_66A-n261I	66	15	Yes	Yes	Yes	Yes								420	
	n261	60	See CA_n261I Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2												
		120												420	
DC_66A-n261J	66	15	Yes	Yes	Yes	Yes								520	
	n261	60	See CA_n261J Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2												
		120												520	
DC_66A-n261K	66	15	Yes	Yes	Yes	Yes								620	
	n261	60	See CA_n261K Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2												
		120												620	
DC_66A-n261L	66	15	Yes	Yes	Yes	Yes								720	
	n261	60	See CA_n261L Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2												
		120												720	
DC_66A-n261M	66	15	Yes	Yes	Yes	Yes								820	
	n261	60	See CA_n261M Bandwidth Combination Fall-back Group 3 in Table 6.X.2-2												
		120												820	
DC_66A-n261O	66	15	Yes	Yes	Yes	Yes								220	4
	n261	60	See CA_n261B Bandwidth Combination Fall-back Group 4 in Table 6.X.2-1												
		120												220	
DC_66A-n261P	66	15	Yes	Yes	Yes	Yes								320	
	n261	60	See CA_n261P Bandwidth Combination Fall-back Group 4 in Table 6.X.2-1												
		120												320	
DC_66A-n261Q	66	15	Yes	Yes	Yes	Yes								420	
	n261	60	See CA_n261Q Bandwidth Combination Fall-back Group 4 in Table 6.X.2-1												
		120												420	

Table 6.93.2-2: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and 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]
DC_66A-n261(2A)	66	15	Yes	Yes	Yes	Yes								420
	n261	60	See CA_ n261(2A) Bandwidth Combination in **Table 8.10.2-1**											
		120												820
DC_66A-n261(3A)	66	15	Yes	Yes	Yes	Yes								620
	n261	60	See CA_ n261(3A) Bandwidth Combination in **Table 8.10.2-1**											
		120												820*
DC_66A-n261(4A)	66	15	Yes	Yes	Yes	Yes								820
	n261	60	See CA_ n261(4A) Bandwidth Combination in **Table 8.10.2-1**											
		120												820*
DC_66A-n261(D-G)	66	15	Yes	Yes	Yes	Yes								620
	n261	60	See CA_n261(D-G) Bandwidth Combination in **Table 8.10.2-2**											
		120												620
DC_66A-n261(D-H)	66	15	Yes	Yes	Yes	Yes								720
	n261	60	See CA_n261(D-H) Bandwidth Combination in **Table 8.10.2-2**											
		120												720
DC_66A-n261(D-I)	66	15	Yes	Yes	Yes	Yes								820
	n261	60	See CA_n261(D-I) Bandwidth Combination in **Table 8.10.2-2**											
		120												820

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DC_66A-n261(D-O)	66	15	Yes	Yes	Yes	Yes								620
	n261	60	See CA_ n261(D-O) Bandwidth Combination in **Table 8.10.2-2**											
		120												620
DC_66A-n261(D-P)	66	15	Yes	Yes	Yes	Yes								720
	n261	60	See CA_ n261(D-P) Bandwidth Combination in **Table 8.10.2-2**											
		120												720
DC_66A-n261(D-Q)	66	15	Yes	Yes	Yes	Yes								820
	n261	60	See CA_ n261(D-Q) Bandwidth Combination in **Table 8.10.2-2**											
		120												820
DC_66A-n261(E-O)	66	15	Yes	Yes	Yes	Yes								820
	n261	60	See CA_n261(E-O) Bandwidth Combination in **Table 8.10.2-2**											
		120												820
DC_66A-n261(E-P)	66	15	Yes	Yes	Yes	Yes								820*
	n261	60	See CA_n261(E-P) Bandwidth Combination in **Table 8.10.2-2**											
		120												820*
DC_66A-n261(E-Q)	66	15	Yes	Yes	Yes	Yes								820*
	n261	60	See CA_n261(E-Q) Bandwidth Combination in **Table 8.10.2-2**											
		120												820*

6.93.3 Co-existence studies

Table 6.93.3-1 lists Band 66A+Band n261 2UL DC 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

Table 6.93.3-1: Band 66 and Band n261 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1710	1780	27500	28350
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3420	3560	55000	56700
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5130	5340	82500	85050
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	26640	25720	29210	30130
Two-tone 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)	24930	23940	53220	54990
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)	30920	31910	56710	58480
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)	1310	2180	27480	28370
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)	53280	51440	58420	60260
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)	23220	22160	80720	83340
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)	32630	33690	84210	86830
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)	111690	108220	20380	21510

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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)	111710	115180	34340	35470
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)	81630	78940	49660	51570
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)	85920	88610	60130	62040

Based on Table **6.93.3-1**;

- 2nd order harmonics may fall into LTE frequencies of Band 22, 42, 48, n77, and n78
- 3rd order harmonic may fall into LTE frequencies of Band 46
- 2nd order IMD products may fall into own Rx frequencies of band n257 and n258
- 3rd order IMD products may fall into Rx frequencies of Band 1, n1, 2, n2, 3, n3, 4, 9, 10, 11, 21, 23, 24, 25, 32, 33, 34, 35, 36, 37, 39, 45, 50, n50, 51, n51, 65, 66, n66, 70, n70, 74, n74, 75, n75, 76, n76, n80, and n84
- 3rd order IMD products may fall into own Rx frequencies of band n257, n258 and n261

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.93.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.93.3-2: 2UL Band 66 +Band n261 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	YES		IMD3
Galileo	1559	-	1591	YES		IMD3
GLONASS	1591	-	1610	YES		IMD3
GPS	1563	-	1587	YES		IMD3
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	YES	US	3rd order harmonic
	5150	-	5350	YES	Europe	3rd order harmonic
	5470	-	5725	No		
	5150	-	5825	YES	Asia	3rd order harmonic

Table 6.93.3-3 lists the protected bands required for the dual connectivity configuration.

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Table 6.93.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_66A-n261	Band 2, 4, 5, 7, 10, 12, 13, 14, 17, 24, 25, 26, 27, 28, 29, 30, 38, 41, 43, 50, 51, 66, 70, 71, 74	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 42, 48	F_{DL_low}	-	F_{DL_high}	-50	1	1
NOTE 1: Table 6.5.3.2-1 of TS38.101							

6.93.4 ΔT_{IB} and ΔR_{IB} values

For DC_66A-n261A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.93.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_66A-n261A	66	0
	n261	0

Table 6.93.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_66A-n261A	66	0
	n261	0

6.93.5 MSD

No IMD issues are expected for DC configuration between the LTE bands below 6GHz and FR2 NR band. Furthermore, up to 7th order harmonics have no impact to Rx frequency of both LTE and NR bands.

6.94 DC_1A_n40A

6.94.1 Operating bands for DC

Table 6.94.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band Combination	E-UTRA and 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}	
DC_1A_n40A	1	1920 MHz – 1980 MHz	2110 MHz – 2170 MHz	FDD
	n40	2300 MHz – 2400 MHz	2300 MHz – 2400 MHz	TDD

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6.94.2 Channel bandwidths per operating band for DC

Table 6.94.2-1 Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	**E-UTRA and NR 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**	**Maximum aggregated bandwidth [MHz]**
DC_1A_n40A	1	15	Yes	Yes	Yes	Yes								70
	n40	15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
		30		Yes	Yes	Yes	Yes	Yes	Yes	Yes				
		60		Yes	Yes	Yes	Yes	Yes	Yes	Yes				

6.94.3 Co-existence studies

Table 6.94.3-1 lists up to 7th harmonic and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 1+Band n40 2UL DC.

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Table 6.94.3-1: Band 1 and Band n40 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1920	1980	2300	2400
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3840	3960	4600	4800
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5760	5940	6900	7200
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	7680	7920	9200	9600
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	9600	9900	11500	12000
6th harmonics frequency limits	6*fx_low	6*fx_high	6* fy_low	6* fy_high
6th harmonics frequency limits (MHz)	11520	11880	13800	14400
7th harmonics frequency limits	7*fx_low	7*fx_high	7* fy_low	7* fy_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|e	|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 6.94.3-1, it can be seen that

- 2nd order harmonic may fall into Rx frequencies of bands n77 and n79.
- 3rd order harmonic may fall into Rx frequencies of band 46 or 47.
- 2nd order IMD may fall into Rx frequencies of bands 31 or 72.
- 3rd order IMD may fall into Rx frequencies of bands 21, 24, 32, 38, 41, 45, 50, 69, 74 or 75.
- 4th order IMD may fall into Rx frequencies of bands 5, 6, 8, 12, 13, 17, 18, 19, 20, 22, 26, 27, 28, 29, 42, 43, 44, 46, 48, 49, 67, 68, 71, 77, 78 or 79.
- 5th order IMD may fall into Rx frequencies of bands 8, 46, 77 or 78.

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When 2UL inter-band EN-DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.94.3-2 lists up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.94.3-2: Band 1 and Band n40 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD3
Galileo	1559	-	1591	Yes		IMD3
GLONASS	1591	-	1610	Yes		IMD3
GPS	1563	-	1587	Yes		IMD3
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	Yes	US	IMD4, IMD5 3rd harmonic
	5150	-	5350	Yes	Europe	IMD4, IMD5
	5470	-	5725	Yes		IMD5
	5150	-	5825	Yes	Asia	IMD4, IMD5 3rd harmonic
45GHz Unlicensed Bands	42300	-	47000	No	China	
	47200	-	48400	No	China	
60GHz Unlicensed Bands	57000	-	66000	No	Europe	
	57050	-	64000	No	USA - Canada	
	57000	-	64000	No	South Korea	
	59000	-	66000	No	Japan	
	59000	-	64000	No	China	
	59400	-	62900	No	Australia	

Table 6.94.3-3 lists the protected bands required for the dual connectivity configuration.

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Table 6.94.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_1A_n40A	Band 1, 5, 7, 8, 11, 18, 19, 20, 21, 22, 26, 27, 28, 31, 32, 38, 40, 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	15
	Frequency range	1880		1895	-40	1	15, 27
	Frequency range	1895		1915	-15.5	5	15, 26, 27
	Frequency range	1915		1920	+1.6	5	15, 26, 27
NOTE 15: 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 26: For these adjacent bands, the emission limit could imply risk of harmful interference to UE(s) operating in the protected operating band. NOTE 27: 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.							

6.94.4 ΔT_{IB} and ΔR_{IB} values

For DC_1A_n40A, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are given in the tables below, and they are reused from LTE combination CA_1A-40A.

Table 6.94.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_1A_n40A	1	0.5
	n40	0.5

Table 6.94.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
DC_1A_n40A	1	0
	n40	0

6.94.5 REFSENS requirements

No IMD issues are expected for this DC configuration and furthermore, up to 7th order harmonics have no impact to Rx frequency in either the LTE band or the NR band. But according to TS 36.101 in table 7.3.1A-0bE, there is a cross band isolation issue for DC_1A_n40A. The MSD for DC_40_n1 is shown as below.

Table 6.94.5-1: Reference sensitivity exceptions (MSD) due to cross band isolation for EN-DC in NR FR1

	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)
1	n40	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6		
n40	1	8.3	8.3	8.3	8.3								

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Table 6.94.5-2: Uplink configuration for reference sensitivity exceptions due to cross band isolation for EN-DC in NR FR1

E-UTRA or NR Band / SCS / Channel bandwidth of the affected DL band / UL RB allocation of the agressor band														
UL band	DL band	SCS of UL band (kHz)	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})	80 MHz (L_{CRB})	90 MHz (L_{CRB})	100 MHz (L_{CRB})
1	n40	15	25	50	75	100	100	100	100	100	100	100		
n40	1	15	25	50	75	100								

6.95 DC_2A_n5A

6.95.1 Operating bands for DC

Table 6.95.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band Combination	E-UTRA and 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}	
DC_2A_n5A	2	1850 MHz – 1910 MHz	1930 MHz – 1990 MHz	FDD
	n5	824 MHz – 849 MHz	869 MHz – 894 MHz	FDD

6.95.2 Channel bandwidths per operating band for DC

Table 6.95.2-1 Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10[1,2] MHz	15[2] MHz	20[2] MHz	25[2] MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Maximum aggregated bandwidth [MHz]
DC_2A_n5A	2	15	Yes	Yes	Yes	Yes								40
	n5	15	Yes	Yes	Yes	Yes								
		30		Yes	Yes	Yes								
		60												
NOTE 1: 90% spectrum utilization may not be achieved for 30kHz SCS. NOTE 2: 90% spectrum utilization may not be achieved for 60kHz SCS. NOTE 3: This UE channel bandwidth is applicable only to downlink.														

6.95.3 Co-existence studies

Table 6.95.3-1 lists up to 7th harmonic and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 2+Band n5 2UL DC.

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Table 6.95.3-1: Band 2 and Band n5 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	824	849	1850	1910
2nd harmonics frequency limits	2* fy_low	2* fy_high	2*fx_low	2*fx_high
2nd harmonics frequency limits (MHz)	1648	1698	3700	3820
3rd harmonics frequency limits	3* fy_low	3* fy_high	3*fx_low	3*fx_high
3rd harmonics frequency limits (MHz)	2472	2547	5550	5730
4th harmonics frequency limits	4* fy_low	4* fy_high	4*fx_low	4*fx_high
4th harmonics frequency limits (MHz)	3296	3396	5550	5730
5th harmonics frequency limits	5* fy_low	5* fy_high	5*fx_low	5*fx_high
5th harmonics frequency limits (MHz)	4120	4245	9250	9550
6th harmonics frequency limits	6* fy_low	6* fy_high	6*fx_low	6*fx_high
6th harmonics frequency limits (MHz)	4944	5094	11100	11460
7th harmonics frequency limits	7* fy_low	7* fy_high	7*fx_low	7*fx_high
7th harmonics frequency limits (MHz)	5768	5943	12950	13370
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	1086	1001	2674	2759
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)	262	152	2851	2996
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)	3498	3608	4524	4669
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)	2172	2002	5348	5518
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)	562	697	4701	4906
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)	4322	4457	6374	6579
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)	6816	6551	1546	1386
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)	8224	8489	5146	5306
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)	4082	3852	1153	1348
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)	7198	7428	6172	6367

Based on Table 6.95.3-1, it can be seen that

- 2nd order harmonic may fall into Rx frequencies of bands 43, 48, 49, 77 and 78.
- 3^{3d} order harmonic may fall into Rx frequencies of bands 41 and 46.
- 2nd order IMD products may fall into Rx frequencies of bands 7 and 41.
- 3^{3d} order IMD products may fall into Rx frequencies of bands 22, 42, 43, 48, 49, 77, 78 and 79.
- 4th order IMD products may fall into Rx frequencies of bands 1, 4, 10, 34, 46, 65, 66, 70, 71 and 79.
- 5th order IMD products may fall into Rx frequencies of bands 11, 21, 24, 32, 45, 46, 50, 51, 74, 75, 76 and 77.

When 2UL inter-band EN-DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.95.3-2 lists up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.95.3-2: Band 2 and Band n5 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	3rd harmonic
	2400	-	2494	Yes	Asia	3rd harmonic
ISM band (5GHz)	5150	-	5925	Yes	US	4th, 5th IMD 3rd harmonic
	5150	-	5350	Yes	Europe	4th, 5th IMD
	5470	-	5725	Yes		4th IMD 3rd harmonic
	5150	-	5825	Yes	Asia	4th, 5th IMD 3rd harmonic
45GHz Unlicensed Bands	42300	-	47000	No	China	
	47200	-	48400	No	China	
60GHz Unlicensed Bands	57000	-	66000	No	Europe	
	57050	-	64000	No	USA - Canada	
	57000	-	64000	No	South Korea	
	59000	-	66000	No	Japan	
	59000	-	64000	No	China	
	59400	-	62900	No	Australia	

Table 6.95.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.95.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_2A_n5A	Bands 4, 5, 10, 12, 13, 14, 17, 24, 28, 29, 30, 42, 48, 50, 51, 66, 70, 71, n71, 74, 85, n257	F_{DL_low}	-	F_{DL_high}	-50	1	
	Bands 2, 25, 48	F_{DL_low}	-	F_{DL_high}	-50	1	3
	E-UTRA Band 26	859	-	869	-27	1	
	E-UTRA Band 41, 43	F_{DL_low}	-	F_{DL_high}	-50	1	2

NOTE 1: F_{DL_low} and F_{DL_high} refer to each E-UTRA frequency band specified in Table 5.5-1of TS 36.101 [2].
NOTE 2: F_{DL_low} and F_{DL_high} refer to each NR frequency band specified in Table 5.2-1 of TS 38.101-1 [3] and 38.101-2 [4].
NOTE 3: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.6.3.1-2 of TS 36.101 [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.

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6.95.4 ΔT_{IB} and ΔR_{IB} values

For DC_2A_n5A, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are derived from LTE combination CA_2A-5A and are given in the tables below.

Table 6.95.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_2A_n5A	2	0.3
	n5	0.3

Table 6.95.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
DC_2A_n5A	2	0
	n5	0

6.95.5 REFSENS requirements

Based on the co-existence studies in 6.95.3, MSD it not needed to be defined for DC_2A_n5A.

6.96 DC_2A_n66A

6.96.1 Operating bands for DC

Table 6.96.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band Combination	E-UTRA and 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}	
DC_2A_n66A	2	1850 MHz – 1910 MHz	1930 MHz – 1990 MHz	FDD
	n66	1710 MHz – 1780 MHz	2110 MHz – 2200 MHz	FDD

6.96.2 Channel bandwidths per operating band for DC

Table 6.96.2-1 Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10[1,2] MHz	15[2] MHz	20[2] MHz	25[2] MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Maximum aggregated bandwidth [MHz]
DC_2A_n66A	2	15	Yes	Yes	Yes	Yes								60
	n66	15	Yes	Yes	Yes	Yes			Yes					
		30		Yes	Yes	Yes			Yes					
		60		Yes	Yes	Yes			Yes					
NOTE 1: 90% spectrum utilization may not be achieved for 30kHz SCS. NOTE 2: 90% spectrum utilization may not be achieved for 60kHz SCS. NOTE 3: This UE channel bandwidth is applicable only to downlink.														

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6.96.3 Co-existence studies

Table 6.96.3-1 lists up to 7th harmonic and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 2+Band n66 2UL DC.

Table 6.96.3-1: Band 2 and Band n66 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1710	1780	1850	1910
2nd harmonics frequency limits	2* fy_low	2* fy_high	2*fx_low	2*fx_high
2nd harmonics frequency limits (MHz)	3420	3560	3700	3820
3rd harmonics frequency limits	3* fy_low	3* fy_high	3*fx_low	3*fx_high
3rd harmonics frequency limits (MHz)	5130	5340	5550	5730
4th harmonics frequency limits	4* fy_low	4* fy_high	4*fx_low	4*fx_high
4th harmonics frequency limits (MHz)	6840	7120	7400	7640
5th harmonics frequency limits	5* fy_low	5* fy_high	5*fx_low	5*fx_high
5th harmonics frequency limits (MHz)	8550	8900	9250	9550
6th harmonics frequency limits	6* fy_low	6* fy_high	6*fx_low	6*fx_high
6th harmonics frequency limits (MHz)	10260	10680	11100	11460
7th harmonics frequency limits	7* fy_low	7* fy_high	7*fx_low	7*fx_high
7th harmonics frequency limits (MHz)	11970	12460	12950	13370
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	200	70	3560	3690
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)	1510	1710	1920	2110
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)	5270	5470	5410	5600
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)	400	140	7120	7380
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)	3220	3490	3770	4020
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)	6980	7250	7260	7510
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)	5930	5620	5270	4930
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)	9110	9420	8690	9030
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)	2310	1990	1640	1310
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)	8970	9290	8830	9160

Based on Table 6.96.3-1, it can be seen that

- 2nd order harmonic may fall into Rx frequencies of bands 22, 42, 43, 48, 49, 77 and 78.
- 3[3d] order harmonic may fall into Rx frequencies of band 46.
- 2nd order IMD products may fall into Rx frequencies of bands 22, 42, 43, 48, 49, 77 and 78.
- 3[3d] order IMD products may fall into Rx frequencies of bands 1, 4, 10, 21, 24, 25, 33, 34, 36, 37, 39, 46, 50, 65, 70, 74, 75, or its own Rx frequencies of band 2 and 66.
- 4th order IMD products may fall into Rx frequencies of bands 42, 43, 77 and 78.

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- 5th order IMD products may fall into Rx frequencies of bands 1, 4, 10, 11, 21, 23, 24, 25, 32, 34, 36, 40, 45, 46, 47, 50, 51, 65, 70, 74, 75, 76, 79, or its own Rx frequencies of band 66.

When 2UL inter-band EN-DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.96.3-2 lists up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.96.3-2: Band 2 and Band n66 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		3rd, 5th IMD
Galileo	1559	-	1591	Yes		3rd, 5th IMD
GLONASS	1591	-	1610	Yes		3rd, 5th IMD
GPS	1563	-	1587	Yes		3rd, 5th IMD
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	Yes	US	3rd, 5th IMD 3rd harmonic
	5150	-	5350	Yes	Europe	3rd, 5th IMD 3rd harmonic
	5470	-	5725	Yes		3rd, 5th IMD 3rd harmonic
	5150	-	5825	Yes	Asia	3rd, 5th IMD 3rd harmonic
45GHz Unlicensed Bands	42300	-	47000	No	China	
	47200	-	48400	No	China	
60GHz Unlicensed Bands	57000	-	66000	No	Europe	
	57050	-	64000	No	USA - Canada	
	57000	-	64000	No	South Korea	
	59000	-	66000	No	Japan	
	59000	-	64000	No	China	
	59400	-	62900	No	Australia	

Table 6.96.3-3 lists the protected bands required for the dual connectivity configuration.

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Table 6.96.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_2A_n66A	Bands 4, 5, 10, 12, 13, 14, 17, 24, 26, 27, 28, 29, 30, 41, 50, 51, 66, 70, 71, n71, 74, 85, n257	F_{DL_low}	-	F_{DL_high}	-50	1	
	Bands 2, 25	F_{DL_low}	-	F_{DL_high}	-50	1	4
	Bands 42, 48	F_{DL_low}	-	F_{DL_high}	-50	1	3

NOTE 1: F_{DL_low} and F_{DL_high} refer to each E-UTRA frequency band specified in Table 5.5-1of TS 36.101 [2].
NOTE 2: F_{DL_low} and F_{DL_high} refer to each NR frequency band specified in Table 5.2-1 of TS 38.101-1 [3] and 38.101-2 [4].
NOTE 3: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.6.3.1-2 of TS 36.101 [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.

6.96.4 ΔT_{IB} and ΔR_{IB} values

For DC_2A_n66A, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are derived from LTE combination CA_2A-66A and are given in the tables below.

Table 6.96.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_2A_n66A	2	0.5
	n66	0.5

Table 6.96.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
DC_2A_n66A	2	0.3
	n66	0.3

6.96.5 REFSENS requirements

Due to 3rd and 5th order IMD MSD are needed and are defined in table 6.96.5-1. Values are reused from existing LTE combination CA_2A-66A.

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Table 6.96.5-1: Reference sensitivity exceptions due to dual uplink operation for EN-DC in NR FR1 (two bands)

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)	Duplex mode	IMD order	Single UL allowed
DC_2A_n66A	2	1855	5	25	1935	20	FDD	IMD3	
	n66	1775	5	25	2175	N/A		N/A	
DC_2A_n66A	2	1883.3	5	25	1963.3	N/A	FDD	N/A	
	n66	1750	5	25	2150	4		IMD5	

6.96.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.96.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.96.6-1.

Table 6.96.6-1: Band 2 and Band n66 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_2A_n66A	2	a	2	b	-1	3	2	IMD
	n66	c	-1	d	0			
DC_2A_n66A	2	a	3	b	0	5	n66	IMD
	n66	c	-2	d	-1			

Equations (6.96.6-1) and (6.96.6-2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.96.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.96.6\text{-}1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.96.6\text{-}2)$$

Formula (6.96.6-3-1) and (6.96.6-3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.96.6\text{-}3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.96.6\text{-}3\text{-}2)$$

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6.97 DC_2A_n78A

6.97.1 Operating bands for DC

Table 6.97.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band	Downlink (DL) band	Duplex mode
		BS receive / UE transmit	BS transmit / UE receive	
		FUL_low – FUL_high	FDL_low – FDL_high	
DC_2A-n78A	2	1850 MHz – 1910 MHz	1930 MHz – 1990 MHz	TDD
	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD

6.97.2 Channel bandwidths per operating band for DC

Table 6.97.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_2A-n78A	2	15	Yes	Yes	Yes	Yes						120
	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	

6.97.3 Co-existence studies

Table 6.x.3-1 provides the self-interference study for DC_2A-n78A.

Table 6.x.3-1 Harmonics and IMD products

E-UTRA and NR DC Configuration	E-UTRA and NR Band	DL frequency range (MHz)	Rx Impact	Harmonic/IMD orders	Notes
DC_2A-n78A	2	1930 MHz -1990 MHz	Yes	IMD2, IMD4, IMD5	
	n78	3300 MHz -3800 MHz	Yes	2th Harmonic	

Table 6.97.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.97.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_2A_n78A	E-UTRA Band 4, 5, 10, 12, 13, 14, 17, 24, 26, 27, 28, 29, 30, 41, 42, 48, 50, 51, 66, 70, 71, 74, 85	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 2, 25	F_{DL_low}	-	F_{DL_high}	-50	1	1
	NR Band 78	F_{DL_low}	-	F_{DL_high}	-50	1	2
	NR Band n257	26500	-	29500	[-5]	100	

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NOTE 1: 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 2: These requirements also apply for the frequency ranges that are less than FOOB (MHz) in Table 6.97.3-3 and [Table x.x.x.x-x] from the edge of the channel bandwidth.

6.97.4 ΔT_{IB} and ΔR_{IB} values

For DC_2A-n78A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.97.4-2: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_2A-n78A	2	0.6
	n78	0.8

Table 6.97.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_2A-n78A	2	0.2
	n78	0.5

6.97.5 MSD

Tables below lists the MSD required for the dual connectivity configuration due to IMD and 2nd harmonic.

Table 6.5.5-1: MSD for the DC configuration for IMD2 and 4

E-UTRA Band / Channel bandwidth / N_{RB} / Duplex mode								Source of IMD
EUTRA/NR DC Configuration	**EUTRA/NR band**	**UL F_c (MHz)**	**UL/DL BW (MHz)**	**UL C_{LRB}**	**DL F_c (MHz)**	**MSD (dB)**	**Duplex mode**	
DC_2A-n78A	2	1855	5	25	1940	26 28.7[5]	FDD	IMD2[4]
	n78	3795	10	25	3795	N/A	TDD	N/A
DC_2A-n78A	2	1885	5	25	1955	[8.0] 10.7[5]	FDD	IMD4[4]
	n78	3700	10	25	3700	N/A	TDD	N/A
NOTE 1: Both of the transmitters shall be set min(+20 dBm, $P_{CMAX\_L,c}$) as defined in subclause 6.2.5A NOTE 2: RB_{START} = 0 NOTE 4: This band is subject to IMD5 also which MSD is not specified. NOTE 5: Applicable only if operation with 4 antenna ports is supported in the band with carrier aggregation configured.								

MSD values for Band n78 due to 2nd harmonic of Band 3 in LTE-NR DC_2-n78 are captured in Table 6.5.5-5.

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Table 6.5.5-2: MSD due to harmonic issue for DC_2-n78

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
2	n78[1,2]	27.1	23.9	22.1	20.9		17.9				
	n78[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.

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 $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$ 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 $\pm\left(20 + BW_{Channel}^{HB} / 2\right)$ MHz offset from $2 f_{UL}^{LB}$ in the victim (higher band) with $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$, where $BW_{Channel}^{LB}$ and $BW_{Channel}^{HB}$ are the channel bandwidths configured in the aggressor (lower) and victim (higher) bands in MHz, respectively.

Regarding the uplink configuration, 40MHz for n78 should be considered additionally. Therefore, 20MHz with 100RB allocation for Band 2 should be added.

Table 6.5.5-3 Uplink configuration for the low band (exceptions) for E-UTRA

E-UTRA Band / Channel bandwidth of the high band / N_{RB} / Duplex mode									
LTE-NR DC band combination	UL band	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz	20 MHz	Duplex mode
DC_2-n78	2			12	26	39	53[1]	100[2]	FDD

NOTE 1: The configuration is used for measurement of MSD for NR channel bandwidth of 20MHz.
NOTE 2: The configuration is used for measurement of MSD for NR channel bandwidth of 40MHz.

6.97.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.97.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.97.6-1.

Table 6.97.6-1: Band 2 and Band n78 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_2A_n78A	2	a	-1	b	-1	2	2	IMD
	n78	c	1	d	0			
DC_2A_n78A	2	a	3	b	-1	4	2	IMD
	n78	c	-1	d	0			
DC_2A_n78A	2	a	-3	b	-1	5	2	IMD
	n78	c	2	d	0			
DC_2A_n78A	2	a	2	b	0	2	n78	Harmonic
	n78	c	0	d	-1			

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Equations (6.97.6-1) and (6.97.6-2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.97.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.97.6\text{-}1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.97.6\text{-}2)$$

Formula (6.97.6-3-1) and (6.97.6-3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.97.6\text{-}3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.97.6\text{-}3\text{-}2)$$

6.98 DC_2A_n260A and DC_2A_n260(2A)

6.98.1 Operating bands for DC

Table 6.98.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band Combination	E-UTRA and NR Band	Uplink (UL) band BS receive / UE transmit F_{UL_low} – F_{UL_high}	Downlink (DL) band BS transmit / UE receive F_{DL_low} – F_{DL_high}	Duplex mode
DC_2A_n260A	2	1850 MHz – 1910 MHz	1930 MHz – 1990 MHz	FDD
	n260	37000 MHz – 40000 MHz	37000 MHz – 40000 MHz	TDD

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6.98.2 Channel bandwidths per operating band for DC

Table 6.98.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	**E-UTRA and 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]**
DC_2A_n260A	2	15	Yes	Yes	Yes	Yes								420 (220 for Band n260 with 60kHz SCS)
	n260	60						Yes			Yes	Yes		
		120						Yes			Yes	Yes	Yes	
DC_2A_n260(2A)	2	15	Yes	Yes	Yes	Yes								820 (420 for Band n260 with 60 kHz SCS)
	n260	60	See CA_n260(2A) Bandwidth Combination in Table 5.5A.2-1 of 38.101-2 [4]											
		120												
DC_2A_n260G	2	15	Yes	Yes	Yes	Yes								220
	n260	60	See CA_n260G Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_2A_n260H	2	15	Yes	Yes	Yes	Yes								320
	n260	60	See CA_n260H Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_2A_n260I	2	15	Yes	Yes	Yes	Yes								420
	n260	60	See CA_n260I Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_2A_n260J	2	15	Yes	Yes	Yes	Yes								520
	n260	60	See CA_n260J Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_2A_n260K	2	15	Yes	Yes	Yes	Yes								620
	n260	60	See CA_n260K Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_2A_n260L	2	15	Yes	Yes	Yes	Yes								720
	n260	60	See CA_n260L Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_2A_n260M	2	15	Yes	Yes	Yes	Yes								820
	n260	60	See CA_n260M Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_2A_n260(A-I)	2	15	Yes	Yes	Yes	Yes								820
	n260	60	See CA_n260(A-I) Bandwidth Combination in Table 5.5A.2-2 of TS 38.101-2											
		120												
DC_2A_n260(G-I)	2	15	Yes	Yes	Yes	Yes								620
	n260	60	See CA_n260(G-I) Bandwidth Combination in Table 5.5A.2-2 of TS 38.101-2											
		120												

6.98.3 Co-existence studies

Table 6.98.3-1 lists up to 7th harmonic and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 2+Band n260 2UL DC.

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Table 6.98.3-1: Band 2 and Band n260 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1850	1910	37000	40000
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3700	3820	74000	80000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5550	5730	111000	120000
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	7400	7640	148000	160000
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	9250	9550	185000	200000
6th harmonics frequency limits	6*fx_low	6*fx_high	6* fy_low	6* fy_high
6th harmonics frequency limits (MHz)	11100	11460	222000	240000
7th harmonics frequency limits	7*fx_low	7*fx_high	7* fy_low	7* fy_high
7th harmonics frequency limits (MHz)	12950	13370	259000	280000
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	38150	35090	38850	41910
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)	36300	33180	72090	78150
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)	40700	43820	75850	81910
4rd 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)	76300	70180	77700	83820
4rd 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)	34450	31270	109090	118150
4rd 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)	42550	45730	112850	121910
5rd 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)	158150	146090	29360	32600
5rd 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)	149850	161910	44400	47640
5rd 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)	116300	107180	68270	74450
5rd 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)	114700	123820	79550	85730

Based on Table 6.98.3-1, it can be seen that

- 2nd order harmonic may fall into Rx frequencies of bands 43, 48, 49, n77 and n78.
- 3rd order harmonic may fall into Rx frequencies of band 46.
- 2nd order IMD may fall into own Rx frequencies of band n260 (which can be disregarded, since no self-interference in TDD).
- 4th order IMD may fall inteo RX frequency of band n259.
- 5th order IMD may fall inteo RX frequency of bands n257 or n259.

Therefore, it can be concluded that there is no harmonic interference and IMD product falling into their own Rx bands.

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When 2UL inter-band EN-DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.98.3-2 lists up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.98.3-2: Band 2 and Band n260 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	Yes	US	3rd harmonic
	5150	-	5350	No	Europe	
	5470	-	5725	Yes		3rd harmonic
	5150	-	5825	Yes	Asia	3rd harmonic
45GHz Unlicensed Bands	42300	-	47000	Yes	China	3rd, 4th, 5th IMD
	47200	-	48400	Yes	China	5th IMD
60GHz Unlicensed Bands	57000	-	66000	No	Europe	
	57050	-	64000	No	USA - Canada	
	57000	-	64000	No	South Korea	
	59000	-	66000	No	Japan	
	59000	-	64000	No	China	
	59400	-	62900	No	Australia	

Table 6.98.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.98.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_2A_n260A	Bands 4, 5, 12, 13, 14, 17, 24, 26, 29, 30, 41, 42, 48, 66, 70, 71, n71, n257	F_{DL_low}	-	F_{DL_high}	-50	1	
	Bands 48	F_{DL_low}	-	F_{DL_high}	-50	1	3

NOTE 1: F_{DL_low} and F_{DL_high} refer to each E-UTRA frequency band specified in Table 5.5-1of TS 36.101 [2].
NOTE 2: F_{DL_low} and F_{DL_high} refer to each NR frequency band specified in Table 5.2-1 of TS 38.101-1 [3] and 38.101-2 [4].
NOTE 3: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.6.3.1-2 of TS 36.101 [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.

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6.98.4 ΔT_{IB} and ΔR_{IB} values

For DC_2A_n260A, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are given in the tables below.

Table 6.98.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_2A_n260A	2	0
	n260	0

Table 6.98.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
DC_2A_n260A	2	0
	n260	0

6.98.5 REFSENS requirements

There is no specific REFSENS requirement.

6.99 DC_3A_n3A

6.99.1 Operating bands for DC

Table 6.99.1-1: DC band combination of LTE 1DL/1UL + one NR band

NR CA Band	NR Band	Uplink (UL) band BS receive / UE transmit F_{UL_low} – F_{UL_high}	Downlink (DL) band BS transmit / UE receive F_{DL_low} – F_{DL_high}	Duplex mode
DC_3_n3	3	1710 MHz – 1785 MHz	1805 MHz – 1880 MHz	FDD
	n3	1710 MHz – 1785 MHz	1805 MHz – 1880 MHz	FDD

6.99.2 Channel bandwidths per operating band for DC

Table 6.99.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

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	100 MHz	Maximum aggregated bandwidth [MHz]
DC_3A_n3A	3	15	Yes	Yes	Yes	Yes								50
	n3	15	Yes	Yes	Yes	Yes	Yes	Yes						
		30		Yes	Yes	Yes	Yes	Yes						
		60		Yes	Yes	Yes	Yes	Yes						

6.99.3 UE co-existence studies

Table 6.99.3-1 gives the UL 2nd, 3rd harmonics for DC_3A_n3A.

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Table 6.99.3-1: Band 3 and Band n3 UL harmonics products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1710	1785	1710	1785
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3420	3570	3420	3570
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5130	5355	5130	5355

Based on Table 6.99.3-1;

2nd order harmonic may fall into Rx frequency of bands 22, 42, 48, n77 and n78

3rd order harmonic may fall into Rx frequencies of bands 46

In Rel.15, Only Single Tx Switched UL mode is supported for this combination, hence, no IMD analysis is need.

6.99.4 ΔT_{IB} and ΔR_{IB} values

No dTib or dRib is required for DC_3A_n3A as it is intra-band DC.

6.99.5 MSD, A-MPR

Note that only Single Tx Switched UL mode is supported for this combination in Rel.15, neither MSD nor A-MPR requirement is needed.

6.99.6 Bandwidth Combination Sets

For intra-band EN-DC combination, it was agreed to allow introduction of bandwidth combination sets. The bandwidth combination set 0 of DC_3A_n3A in Rel.15 is shown in Table 6.99.6-1.

Table 6.99.6-1: Bandwidth Combination Sets for DC_3A_n3A

		E-UTRA – NR configuration / Bandwidth combination set				
Downlink EN-DC configuration	Uplink EN-DC configurations	Component carriers in order of increasing carrier frequency			Maximum aggregated bandwidth (MHz)	Bandwidth combination set
		Channel bandwidths for LTE carrier (MHz)	Channel bandwidths NR for carrier (MHz)	Channel bandwidths for LTE carrier (MHz)		
DC_3A_n3A	DC_3A_n3A(1)		5, 10, 15, 20, 25, 30	5, 10, 15, 20	50	0

6.99.7 delta R INBC values

For the UE which supports intra-band EN-DC DC_3A_n3A configuration, the minimum requirement for reference sensitivity shall be increased by the amount given in ΔRIBNC in Table 6.99.7-1. According to the bandwidth combination set in Table 6.99.6-1, the LTE UL will always be closer to the DL band, so that the UL allocation is for the LTE part, and the ΔRIBNC is applied to the NR part.

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Table 6.99.7-1: Delta R IBNC for DC_3A_n3A

DC configuration	Aggregated channel bandwidth (LTE+NR)	W_{gap} / (MHz)	UL LTE allocation	ΔR_{IBNC} (dB)	Duplex mode
DC_3A_n3A	5MHz+5MHz	$45.0 < W_{gap} \leq 65.0$	12^1	4.7	FDD
		$0.0 < W_{gap} \leq 45.0$	25^1	0	
	5MHz+10MHz	$40.0 < W_{gap} \leq 60.0$	12^1	3.8	
		$0.0 < W_{gap} \leq 40.0$	25^1	0	
	5MHz+15MHz	$35.0 < W_{gap} \leq 55.0$	12^1	3.6	
		$0.0 < W_{gap} \leq 35.0$	25^1	0	
	5MHz+20MHz	$30.0 < W_{gap} \leq 50.0$	12^1	3.4	
		$0.0 < W_{gap} \leq 30.0$	25^1	0	
	5MHz+25MHz	$25.0 < W_{gap} \leq 45.0$	12^1	3.2	
		$0.0 < W_{gap} \leq 25.0$	25^1	0	
	5MHz+30MHz	$20.0 < W_{gap} \leq 40.0$	12^1	3.0	
		$0.0 < W_{gap} \leq 20.0$	25^1	0	
	10MHz+5MHz	$30.0 < W_{gap} \leq 60.0$	12^5	5.1	
		$0.0 < W_{gap} \leq 30.0$	32^1	0	
	10MHz+10MHz	$25.0 < W_{gap} \leq 55.0$	12^5	4.3	
		$0.0 < W_{gap} \leq 25.0$	32^1	0	
	10MHz+15MHz	$20.0 < W_{gap} \leq 50.0$	12^5	3.8	
		$0.0 < W_{gap} \leq 20.0$	32^1	0	
	10MHz+20MHz	$15.0 < W_{gap} \leq 45.0$	12^5	3.5	
		$0.0 < W_{gap} \leq 15.0$	32^1	0	
	10MHz+25MHz	$10.0 < W_{gap} \leq 40.0$	12^5	3.2	
		$0.0 < W_{gap} \leq 10.0$	32^1	0	
	10MHz+30MHz	$5.0 < W_{gap} \leq 35.0$	12^5	2.8	
		$0.0 < W_{gap} \leq 5.0$	32^1	0	
	15MHz+5MHz	$25.0 < W_{gap} \leq 55.0$	12^6	6.0	
		$0.0 < W_{gap} \leq 25.0$	32^1	0	
	15MHz+10MHz	$20.0 < W_{gap} \leq 50.0$	12^6	4.7	
		$0.0 < W_{gap} \leq 20.0$	32^1	0	
	15MHz+15MHz	$15.0 < W_{gap} \leq 45.0$	12^6	4.2	
		$0.0 < W_{gap} \leq 15.0$	32^1	0	
	15MHz+20MHz	$10.0 < W_{gap} \leq 40.0$	12^6	3.8	
		$0.0 < W_{gap} \leq 10.0$	32^1	0	
	15MHz+25MHz	$5.0 < W_{gap} \leq 35.0$	12^6	3.5	
		$0.0 < W_{gap} \leq 5.0$	32^1	0	
	15MHz+30MHz	$0.0 < W_{gap} \leq 30.0$	12^6	3.3	
	20MHz+5MHz	$15.0 < W_{gap} \leq 50.0$	16^7	6.5	
		$0.0 < W_{gap} \leq 15.0$	32^1	0	
	20MHz+10MHz	$10.0 < W_{gap} \leq 45.0$	16^7	5.1	
		$0.0 < W_{gap} \leq 10.0$	32^1	0	
	20MHz+15MHz	$5.0 < W_{gap} \leq 40.0$	16^7	4.5	
		$0.0 < W_{gap} \leq 5.0$	32^1	0	
	20MHz+20MHz	$0.0 < W_{gap} \leq 35.0$	16^7	4.1	
	20MHz+25MHz	$0.0 < W_{gap} \leq 30.0$	16^7	3.8	
	20MHz+30MHz	$0.0 < W_{gap} \leq 25.0$	16^7	3.6	

NOTE 1: [1] refers to the UL resource blocks shall be located as close as possible to the downlink operating band but confined within the transmission.
NOTE 2: W_{gap} is the sub-block gap between the two sub-blocks.
NOTE 3: The carrier center frequency of PCC in the UL operating band is configured closer to the DL operating band.
NOTE 4: All combinations of channel bandwidths defined in Table 5.3B.1.3-1.
NOTE 5: [5] refers to the UL resource blocks shall be located at RB_{start}=25.
NOTE 6: [6] refers to the UL resource blocks shall be located at RB_{start}=35.
NOTE 7: [7] refers to the UL resource blocks shall be located at RB_{start}=50.

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6.100 DC_3A_n40A

6.100.1 Operating bands for DC

Table 6.100.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band Combination	E-UTRA and 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}	
DC_3A_n40A	3	1710 MHz – 1785 MHz	1805 MHz – 1880 MHz	FDD
	n40	2300 MHz – 2400 MHz	2300 MHz – 2400 MHz	TDD

6.100.2 Channel bandwidths per operating band for DC

Table 6.100.2-1 Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and NR 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	Maximum aggregated bandwidth [MHz]
DC_3A_n40A	3	15	Yes	Yes	Yes	Yes								70
	n40	15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
		30		Yes	Yes	Yes	Yes	Yes	Yes	Yes				
		60		Yes	Yes	Yes	Yes	Yes	Yes	Yes				

6.100.3 Co-existence studies

Table 6.100.3-1 lists up to 7th harmonic and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 3+Band n40 2UL DC.

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Table 6.100.3-1: Band 3 and Band n40 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1710	1785	2300	2400
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	3420	3570	4600	4800
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	5130	5355	6900	7200
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	6840	7140	9200	9600
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	8550	8925	11500	12000
6th harmonics frequency limits	6*fx_low	6*fx_high	6* fy_low	6* fy_high
6th harmonics frequency limits (MHz)	10260	10710	13800	14400
7th harmonics frequency limits	7*fx_low	7*fx_high	7* fy_low	7* fy_high
7th harmonics frequency limits (MHz)	11970	12495	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)	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

Based on Table 6.100.3-1, it can be seen that

- 2nd order harmonic may fall into Rx frequencies of bands 22, 42, 48, 49, 77, 78 and 79.
- 3rd order harmonic may fall into Rx frequencies of band 46.
- 2nd order IMD may fall into Rx frequencies of bands 71 or 77.
- 3rd order IMD may fall into Rx frequencies of bands 46 or 47.
- 4th order IMD may fall into Rx frequencies of band 46.
- 5th order IMD may fall into Rx frequencies of bands 42, 43, 44, 48, 49, 67, 68, 71, 77, 78, 79.

When 2UL inter-band EN-DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.100.3-2 lists up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.100.3-2: Band 3 and Band n40 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	Yes	US	IMD4 3rd harmonic
	5150	-	5350	Yes	Europe	IMD3, IMD4 3rd harmonic
	5470	-	5725	Yes		IMD3, IMD4
	5150	-	5825	Yes	Asia	IMD3, IMD4 3rd harmonic
45GHz Unlicensed Bands	42300	-	47000	No	China	
	47200	-	48400	No	China	
60GHz Unlicensed Bands	57000	-	66000	No	Europe	
	57050	-	64000	No	USA - Canada	
	57000	-	64000	No	South Korea	
	59000	-	66000	No	Japan	
	59000	-	64000	No	China	
	59400	-	62900	No	Australia	

Table 6.100.3-3 lists the protected bands required for the dual connectivity configuration.

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Table 6.100.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_3A_n40A	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	FDL_low	-	FDL_high	-50	1	
	Band 3	FDL_low	-	FDL_high	-50	1	15
	Band 22, 42, 52	FDL_low	-	FDL_high	-50	1	2
	Frequency range	1884.5	-	1915.7	-41	0.3	13
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 13: This requirement applies for 5, 10, 15 and 20 MHz E-UTRA channel bandwidth allocated within 1744.9MHz and 1784.9MHz. NOTE 15: 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.							

6.100.4 ΔT_{IB} and ΔR_{IB} values

For DC_3A_n40A, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are given in the tables below, and they are reused from LTE combination CA_3A-40A.

Table 6.100.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_3A_n40A	3	0.5
	n40	0.5

Table 6.100.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
DC_3A_n40A	3	0
	n40	0

6.100.5 REFSENS requirements

No IMD issues are expected for this DC configuration and furthermore, up to 7th order harmonics have no impact to Rx frequency in either the LTE band or the NR band.

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6.101 DC_5A_n40A

6.101.1 Operating bands for DC

Table 6.101.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band Combination	E-UTRA and 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}	
DC_5A_n40A	5	824 MHz – 849 MHz	869 MHz – 894 MHz	FDD
	n40	2300 MHz – 2400 MHz	2300 MHz – 2400 MHz	TDD

6.101.2 Channel bandwidths per operating band for DC

Table 6.101.2-1 Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and NR 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	Maximum aggregated bandwidth [MHz]
DC_5A_n40A	5	15	Yes	Yes										60
	n40	15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
		30		Yes	Yes	Yes	Yes	Yes	Yes	Yes				
		60		Yes	Yes	Yes	Yes	Yes	Yes	Yes				

6.101.3 Co-existence studies

Table 6.101.3-1 lists up to 7th harmonic and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 5+Band n40 2UL DC.

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Table 6.101.3-1: Band 5 and Band n40 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	824	849	2300	2400
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1648	1698	4600	4800
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2472	2547	6900	7200
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	3296	3396	9200	9600
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	4120	4245	11500	12000
6th harmonics frequency limits	6*fx_low	6*fx_high	6* fy_low	6* fy_high
6th harmonics frequency limits (MHz)	4944	5094	13800	14400
7th harmonics frequency limits	7*fx_low	7*fx_high	7* fy_low	7* fy_high
7th harmonics frequency limits (MHz)	5768	5943	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)	1576	1451	3124	3249
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)	752	602	3751	3976
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)	3948	4098	5424	5649
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)	3152	2902	6248	6498
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)	72	247	6051	6376
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)	4772	4947	7724	8049
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)	8776	8351	1096	896
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)	10024	10449	5596	5796
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)	5552	5202	2053	2328
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)	8548	8898	7072	7347

Based on Table 6.101.3-1, it can be seen that

- 2nd order harmonic may fall into Rx frequencies of band 79.
- 3rd order harmonic may fall into Rx frequencies of band 41.
- 2nd order IMD may fall into Rx frequencies of bands 11, 21, 24, 32, 45, 50, 74 and 75.
- 3rd order IMD may fall into Rx frequencies of bands 12, 13, 17, 29, 43, 44, 46, 67, 71, 77, 78.
- 4th order IMD may fall into Rx frequencies of band 79.
- 5th order IMD may fall into Rx frequencies of bands 1, 4, 8 10, 23, 46, 65 and 66, and also the own RX frequency of band 40..

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When 2UL inter-band EN-DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.101.3-2 lists up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.101.3-2: Band 5 and Band n40 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD2
Galileo	1559	-	1591	Yes		IMD2
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	Yes		IMD2
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	3rd harmonic
	2400	-	2494	Yes	Asia	3rd harmonic
ISM band (5GHz)	5150	-	5925	Yes	US	IMD3. IMD5
	5150	-	5350	Yes	Europe	IMD5
	5470	-	5725	Yes		IMD3, IMD5
	5150	-	5825	Yes	Asia	IMD3, IMD5
45GHz Unlicensed Bands	42300	-	47000	No	China	
	47200	-	48400	No	China	
60GHz Unlicensed Bands	57000	-	66000	No	Europe	
	57050	-	64000	No	USA - Canada	
	57000	-	64000	No	South Korea	
	59000	-	66000	No	Japan	
	59000	-	64000	No	China	
	59400	-	62900	No	Australia	

Table 6.101.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.101.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_5A_n40A	Band 1, 3, 5, 7, 8, 28, 31, 34, 38, 42, 43, 45, 65, 73	F_{DL_low}	-	F_{DL_high}	-50	1	
	Band 26	859	-	869	-27	1	
	Band 41, 52	F_{DL_low}	-	F_{DL_high}	-50	1	2
	Frequency range	1884.5	-	1915.7	-41	0.3	4
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. In case the exceptions are allowed 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 or 4 for the 2nd, 3rd or 4th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval. NOTE 4: Applicable when co-existence with PHS system operating in 1884.5 -1915.7MHz.							

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6.101.4 ΔT_{IB} and ΔR_{IB} values

For DC_5A_n40A, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are given in the tables below, and they are reused from LTE combination CA_5A-40A.

Table 6.101.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_5A_n40A	5	0.3
	n40	0.3

Table 6.101.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
DC_5A_n40A	5	0
	n40	0

6.101.5 REFSENS requirements

No issues up to 4th order IMD are expected for this DC configuration and furthermore, up to 7th order harmonics have no impact to Rx frequency in either the LTE band or the NR band.

6.102 DC_5A_n66A

6.102.1 Operating bands for DC

Table 6.102.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band Combination	E-UTRA and 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}	
DC_5A_n66A	5	824 MHz – 849 MHz	869 MHz – 894 MHz	FDD
	n66	1710 MHz – 1780 MHz	2110 MHz – 2200 MHz	FDD

6.102.2 Channel bandwidths per operating band for DC

Table 6.102.2-1 Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10[1,2] MHz	15[2] MHz	20[2] MHz	25[2] MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Maximum aggregated bandwidth [MHz]
DC_5A_n66A	5	15	Yes	Yes										50
	n66	15	Yes	Yes	Yes	Yes			Yes					
		30		Yes	Yes	Yes			Yes					
		60		Yes	Yes	Yes			Yes					
NOTE 1: 90% spectrum utilization may not be achieved for 30kHz SCS. NOTE 2: 90% spectrum utilization may not be achieved for 60kHz SCS. NOTE 3: This UE channel bandwidth is applicable only to downlink.														

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6.102.3 Co-existence studies

Table 6.102.3-1 lists up to 7th harmonic and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 5+Band n66 2UL DC.

Table 6.102.3-1: Band 5 and Band n66 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	824	849	1710	1780
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1648	1698	3420	3560
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd 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
6th harmonics frequency limits	6*fx_low	6*fx_high	6* fy_low	6* fy_high
6th harmonics frequency limits (MHz)	4944	5094	10260	10680
7th harmonics frequency limits	7*fx_low	7*fx_high	7* fy_low	7* fy_high
7th harmonics frequency limits (MHz)	5768	5943	11970	12460
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	956	861	2534	2629
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)	132	12	2571	2736
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)	3358	3478	4244	4409
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)	1912	1722	5068	5258
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)	692	837	4281	4516
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)	4182	4327	5954	6189
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)	6296	5991	1686	1516
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)	7664	7969	5006	5176
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)	3692	3432	873	1088
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)	6778	7038	5892	6107

Based on Table 6.102.3-1, it can be seen that

- 2nd order harmonic may fall into Rx frequencies of bands 22, 42, 48, 49, 77 and 78.
- 3[3d] order harmonic may fall into Rx frequencies of bands 41 and 46.
- 2nd order IMD products may fall into Rx frequencies of bands 6, 7, 8, 18, 19, 26, 27, 38, 41 and 69, or its own RX frequency in band 5.
- 3[3d] order IMD products may fall into Rx frequencies of bands 7, 38, 41, 42, 69, 77, 78 and 79.

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- 4th order IMD products may fall into Rx frequencies of bands 3, 9, 12, 13, 17, 20, 28, 29, 33, 35, 37, 39, 44, 46, 67, 68, 77 and 79.

- 5th order IMD products may fall into Rx frequencies of bands 6, 8, 18, 19, 22, 24, 26, 42, 43, 46, 47, 48, 49, 50, 74, 75, 77 and 78, or its own RX frequency in band 5.

When 2UL inter-band EN-DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.102.3-2 lists up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.102.3-2: Band 5 and Band n66 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		5th IMD
Galileo	1559	-	1591	Yes		5th IMD
GLONASS	1591	-	1610	Yes		5th IMD
GPS	1563	-	1587	Yes		5th IMD
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	3rd harmonic
	2400	-	2494	Yes	Asia	3rd harmonic
ISM band (5GHz)	5150	-	5925	Yes	US	4th, 5th IMD 3rd harmonic
	5150	-	5350	Yes	Europe	4th, 5th IMD 3rd harmonic
	5470	-	5725	No		
	5150	-	5825	Yes	Asia	4th, 5th IMD 3rd harmonic
45GHz Unlicensed Bands	42300	-	47000	No	China	
	47200	-	48400	No	China	
60GHz Unlicensed Bands	57000	-	66000	No	Europe	
	57050	-	64000	No	USA - Canada	
	57000	-	64000	No	South Korea	
	59000	-	66000	No	Japan	
	59000	-	64000	No	China	
	59400	-	62900	No	Australia	

Table 6.102.3-3 lists the protected bands required for the dual connectivity configuration.

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Table 6.102.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_5A_n66A	Bands 1, 2, 3, 4, 5, 6, 7, 8, 10, 12, 13, 14, 17, 24, 25, 28, 29, 30, 34, 38, 40, 43, 45, 50, 51, 65, 66, 70, 71, n71, 85, n257	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 26	859	-	869	-27	1	
	Bands 41, 42, 48, 52	F_{DL_low}	-	F_{DL_high}	-50	1	3
	E-UTRA Band 18, 19	F_{DL_low}	-	F_{DL_high}	-40	1	5
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	5
	Frequency range	1884.5	-	1915.7	-41	0.3	4, 5

NOTE 1: F_{DL_low} and F_{DL_high} refer to each E-UTRA frequency band specified in Table 5.5-1of TS 36.101 [2].
NOTE 2: F_{DL_low} and F_{DL_high} refer to each NR frequency band specified in Table 5.2-1 of TS 38.101-1 [3] and 38.101-2 [4].
NOTE 3: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.6.3.1-2 of TS 36.101 [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: Applicable when co-existence with PHS system operating in 1884.5 -1915.7MHz.
NOTE 5: Applicable only when the assigned E-UTRA carrier is confined within 824 MHz and 849 MHz for UE category M1, M2 and UE category NB1 and NB2

6.102.4 ΔT_{IB} and ΔR_{IB} values

For DC_5A_n66A, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are derived from LTE combination CA_5A-66A and are given in the tables below.

Table 6.102.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_5A_n66A	5	0.3
	n66	0.3

Table 6.102.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
DC_5A_n66A	5	0
	n66	0

6.102.5 REFSENS requirements

Due to 2nd order IMD MSD are needed and are defined in table 6.102.5-1. Values are reused from existing LTE combination CA_5A-66A.

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Table 6.102.5-1: Reference sensitivity exceptions due to dual uplink operation for EN-DC in NR FR1 (two bands)

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)	Duplex mode	IMD order	Single UL allowed
DC_5A_n66A	5	838	5	25	883	30	FDD	IMD2[1]	
	n66	1721	5	25	2121	N/A		N/A	
NOTE 1: This band is subject to IMD5 also which MSD is not specified.									

6.102.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.102.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.102.6-1.

Table 6.102.6-1: Band 5 and Band n66 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_5A_n66A	5	a	-1	b	-1	2	5	IMD
	n66	c	1	d	0			
DC_5A_n66A	5	a	-3	b	-1	5	5	IMD
	n66	c	2	d	0			

Equations (6.102.6-1) and (6.102.6-2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.102.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.102.6\text{-}1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.102.6\text{-}2)$$

Formula (6.102.6-3-1) and (6.102.6-3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.102.6\text{-}3\text{-}1)$$

$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.102.6\text{-}3\text{-}2)$$

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6.103 DC_8A_n40A

6.103.1 Operating bands for DC

Table 6.103.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band Combination	E-UTRA and 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}	
DC_8A_n40A	8	880 MHz – 915 MHz	925 MHz – 960 MHz	FDD
	n40	2300 MHz – 2400 MHz	2300 MHz – 2400 MHz	TDD

6.103.2 Channel bandwidths per operating band for DC

Table 6.103.2-1 Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and NR 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	Maximum aggregated bandwidth [MHz]
DC_8A_n40A	8	15	Yes	Yes										60
	n40	15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
		30		Yes	Yes	Yes	Yes	Yes	Yes	Yes				
		60		Yes	Yes	Yes	Yes	Yes	Yes	Yes				

6.103.3 Co-existence studies

Table 6.103.3-1 lists up to 7th harmonic and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 8+Band n40 2UL DC.

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Table 6.103.3-1: Band 8 and Band n40 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	880	915	2300	2400
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1760	1830	4600	4800
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2640	2745	6900	7200
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	3520	3660	9200	9600
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	4400	4575	11500	12000
6th harmonics frequency limits	6*fx_low	6*fx_high	6* fy_low	6* fy_high
6th harmonics frequency limits (MHz)	5280	5490	13800	14400
7th harmonics frequency limits	7*fx_low	7*fx_high	7* fy_low	7* fy_high
7th harmonics frequency limits (MHz)	6160	6405	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)	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 6.103.3-1, it can be seen that

- 2nd order harmonic may fall into Rx frequencies of bands 3 and 79.
- 3rd order harmonic may fall into Rx frequencies of bands 7 and 41.
- 2nd order IMD may fall into Rx frequencies of bands 11, 21, 32, 45, 50, 51, 74, 75, 76, 77 and 78.
- 3rd order IMD may fall into Rx frequencies of bands 43, 46, 48, 49, 71, 77 and 78.
- 4th order IMD may fall into Rx frequencies of band 79.
- 5th order IMD may fall into Rx frequencies of bands 1,2, 3, 4, 9, 10, 25, 33, 34, 35, 36, 37, 39, 46, 47, 65, 66 and 70.

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When 2UL inter-band EN-DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.103.3-2 lists up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.103.3-2: Band 8 and Band n40 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	Yes	US	IMD3, IMD5
	5150	-	5350	No	Europe	
	5470	-	5725	Yes		IMD3, IMD5
	5150	-	5825	Yes	Asia	IMD3, IMD5
45GHz Unlicensed Bands	42300	-	47000	No	China	
	47200	-	48400	No	China	
60GHz Unlicensed Bands	57000	-	66000	No	Europe	
	57050	-	64000	No	USA - Canada	
	57000	-	64000	No	South Korea	
	59000	-	66000	No	Japan	
	59000	-	64000	No	China	
	59400	-	62900	No	Australia	

Table 6.103.3-3 lists the protected bands required for the dual connectivity configuration.

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Table 6.103.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_8A_n40A	Band 1, 20, 28, 31, 32, 33, 34, 38, 39, 40, 45, 50, 51, 65, 67, 68, 69, 72, 73, 74, 75, 76	F_{DL_low}	-	F_{DL_high}	-50	1	
	Band 3, 7, 22, 41, 42, 43, 52	F_{DL_low}	-	F_{DL_high}	-50	1	2
	Band 8	F_{DL_low}	-	F_{DL_high}	-50	1	15
	Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	23
	Frequency range	860	-	890	-40	1	15, 23
	Frequency range	1884.5	-	1915.7	-41	0.3	8, 23

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 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 6.6.3.1-1 and Table 6.6.3.1A-1 from the edge of the channel bandwidth.

NOTE 23: 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 MHz ≤ F_c < 907.5 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 MHz ≤ F_c ≤ 912.5 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 MHz with an uplink transmission bandwidth less than or equal to 32 RB with RB_{start} > 3.

6.103.4 ΔT_{IB} and ΔR_{IB} values

For DC_8A_n40A, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are given in the tables below, and they are reused from LTE combination CA_8A-40A.

Table 6.103.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_8A_n40A	8	0.3
	n40	0.3

Table 6.103.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
DC_8A_n40A	8	0
	n40	0

6.103.5 REFSENS requirements

No IMD issues are expected for this DC configuration and furthermore, up to 7th order harmonics have no impact to Rx frequency in either the LTE band or the NR band.

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6.104 DC_12A_n5A

6.104.1 Operating bands for DC

Table 6.104.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band Combination	E-UTRA and 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}	
DC_12A_n5A	12	699 MHz – 716 MHz	729 MHz – 746 MHz	FDD
	n5	824 MHz – 849 MHz	869 MHz – 894 MHz	FDD

6.104.2 Channel bandwidths per operating band for DC

Table 6.104.2-1 Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10[1,2] MHz	15[2] MHz	20[2] MHz	25[2] MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Maximum aggregated bandwidth [MHz]
DC_12A_n5A	12	15	Yes	Yes										30
	n5	15	Yes	Yes	Yes	Yes								
		30		Yes	Yes	Yes								
		60												
NOTE 1: 90% spectrum utilization may not be achieved for 30kHz SCS. NOTE 2: 90% spectrum utilization may not be achieved for 60kHz SCS. NOTE 3: This UE channel bandwidth is applicable only to downlink.														

6.104.3 Co-existence studies

Table 6.104.3-1 lists up to 7th harmonic and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 12+Band n5 2UL DC.

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Table 6.104.3-1: Band 12 and Band n5 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	699	716	824	849
2nd harmonics frequency limits	2* fy_low	2* fy_high	2*fx_low	2*fx_high
2nd harmonics frequency limits (MHz)	1398	1432	1648	1698
3rd harmonics frequency limits	3* fy_low	3* fy_high	3*fx_low	3*fx_high
3rd harmonics frequency limits (MHz)	2097	2148	2472	2547
4th harmonics frequency limits	4* fy_low	4* fy_high	4*fx_low	4*fx_high
4th harmonics frequency limits (MHz)	2796	2864	3296	3396
5th harmonics frequency limits	5* fy_low	5* fy_high	5*fx_low	5*fx_high
5th harmonics frequency limits (MHz)	3495	3580	4120	4245
6th harmonics frequency limits	6* fy_low	6* fy_high	6*fx_low	6*fx_high
6th harmonics frequency limits (MHz)	4194	4296	4944	5094
7th harmonics frequency limits	7* fy_low	7* fy_high	7*fx_low	7*fx_high
7th harmonics frequency limits (MHz)	4893	5012	5768	5943
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	150	108	1523	1565
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)	549	608	932	999
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)	2222	2281	2347	2414
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)	300	216	3046	3130
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)	1248	1324	1756	1848
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)	2921	2997	3171	3263
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)	2697	2580	2040	1947
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)	3995	4112	3620	3713
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)	1149	1040	500	399
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)	3870	3979	3745	3846

Based on Table 6.104.3-1, it can be seen that

- 2nd order harmonic may fall into Rx frequencies of bands 50, 51, 75 and 76.
- 3^{3d} order harmonic may fall into Rx frequencies of bands 1, 4, 10, 41, 65 and 66.
- 2nd order IMD products may fall into Rx frequencies of band 24.
- 3^{3d} order IMD products may fall into Rx frequencies of bands 8, 30 and 40.
- 4th order IMD products may fall into Rx frequencies of bands 3 and 9.
- 5th order IMD products may fall into Rx frequencies of bands 2, 7 25, 31, 34, 36, 38, 41, 43, 48, 49, 69, 70, 72, 77 and 78.

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When 2UL inter-band EN-DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.104.3-2 lists up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.104.3-2: Band 12 and Band n5 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		2nd IMD
Galileo	1559	-	1591	Yes		2nd IMD
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	Yes		2nd IMD
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	3rd IMD 3rd harmonic
	2400	-	2494	Yes	Asia	3rd IMD 3rd harmonic
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	
45GHz Unlicensed Bands	42300	-	47000	No	China	
	47200	-	48400	No	China	
60GHz Unlicensed Bands	57000	-	66000	No	Europe	
	57050	-	64000	No	USA - Canada	
	57000	-	64000	No	South Korea	
	59000	-	66000	No	Japan	
	59000	-	64000	No	China	
	59400	-	62900	No	Australia	

Table 6.104.3-3 lists the protected bands required for the dual connectivity configuration.

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Table 6.104.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_12A_n5A	Bands 2, 5, 12, 13, 14, 17, 24, 25, 30, 42, 43 50, 51, 71, n71, 74, n257	F_{DL_low}	-	F_{DL_high}	-50	1	
	Bands 4, 10, 41, 48, 66, 70	F_{DL_low}	-	F_{DL_high}	-50	1	2
	Band 26	859	-	869	-27	1	
	Band 12, 85	F_{DL_low}	-	F_{DL_high}	-50	1	3

NOTE 1: F_{DL_low} and F_{DL_high} refer to each E-UTRA frequency band specified in Table 5.5-1of TS 36.101 [2].
NOTE 2: F_{DL_low} and F_{DL_high} refer to each NR frequency band specified in Table 5.2-1 of TS 38.101-1 [3] and 38.101-2 [4].
NOTE 3: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.6.3.1-2 of TS 36.101 [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.

6.104.4 ΔT_{IB} and ΔR_{IB} values

For DC_12A_n5A, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are derived from LTE combination CA_5A-12A and are given in the tables below.

Table 6.104.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_12A_n5A	12	0.4
	n5	0.8

Table 6.104.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
DC_12A_n5A	12	0.3
	n5	0.5

6.104.5 REFSENS requirements

Based on the co-existence studies in 6.104.3, MSD it not needed to be defined for DC_12A_n5A.

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6.105 DC_12A_n66A

6.105.1 Operating bands for DC

Table 6.105.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band Combination	E-UTRA and 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}	
DC_12A_n66A	12	699 MHz – 716 MHz	729 MHz – 746 MHz	FDD
	n66	1710 MHz – 1780 MHz	2110 MHz – 2200 MHz	FDD

6.105.2 Channel bandwidths per operating band for DC

Table 6.105.2-1 Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10[1,2] MHz	15[2] MHz	20[2] MHz	25[2] MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Maximum aggregated bandwidth [MHz]
DC_12A_n66A	12	15	Yes	Yes										50
	n66	15	Yes	Yes	Yes	Yes			Yes					
		30		Yes	Yes	Yes			Yes					
		60		Yes	Yes	Yes			Yes					
NOTE 1: 90% spectrum utilization may not be achieved for 30kHz SCS. NOTE 2: 90% spectrum utilization may not be achieved for 60kHz SCS. NOTE 3: This UE channel bandwidth is applicable only to downlink.														

6.105.3 Co-existence studies

Table 6.105.3-1 lists up to 7th harmonic and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 12+Band n66 2UL DC.

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Table 6.105.3-1: Band 12 and Band n66 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	699	716	1710	1780
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1398	1432	3420	3560
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2097	2148	5130	5340
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	2796	2864	6840	7120
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	3495	3580	8550	8900
6th harmonics frequency limits	6*fx_low	6*fx_high	6* fy_low	6* fy_high
6th harmonics frequency limits (MHz)	4194	4296	10260	10680
7th harmonics frequency limits	7*fx_low	7*fx_high	7* fy_low	7* fy_high
7th harmonics frequency limits (MHz)	4893	5012	11970	12460
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	1081	994	2409	2496
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)	382	278	2704	2861
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)	3108	3212	4119	4276
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)	2162	1988	4818	4992
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)	317	438	4414	4641
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)	3807	3928	5829	6056
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)	6421	6124	1154	1016
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)	7539	7836	4506	4644
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)	3942	3698	1272	1463
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)	6528	6772	5517	5708

Based on Table 6.105.3-1, it can be seen that

- 2nd order harmonic may fall into Rx frequencies of bands 22, 42, 48, 49, 50, 51, 75, 76, 77, 78 and 79.
- 3^{3d} order harmonic may fall into Rx frequencies of bands 1, 4, 10, 46 and 65 or its own RX frequency in band 66.
- 2nd order IMD products may fall into Rx frequencies of band 41.
- 3^{3d} order IMD products may fall into Rx frequencies of band 77.
- 4th order IMD products may fall into Rx frequencies of bands 1, 2, 4, 10, 25, 34, 36, 46, 47, 65, 70, 77 and 79 or its own RX frequency in band 66.
- 5th order IMD products may fall into Rx frequencies of bands 32, 43, 45, 46, 48, 49, 50, 51, 75, 76, 77, 78 and 79.

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When 2UL inter-band EN-DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.105.3-2 lists up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.105.3-2: Band 12 and Band n66 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	2nd IMD
	2400	-	2494	Yes	Asia	2nd IMD
ISM band (5GHz)	5150	-	5925	Yes	US	4th, 5th IMD
	5150	-	5350	No	Europe	
	5470	-	5725	Yes		5th IMD
	5150	-	5825	Yes	Asia	5th IMD
45GHz Unlicensed Bands	42300	-	47000	No	China	
	47200	-	48400	No	China	
60GHz Unlicensed Bands	57000	-	66000	No	Europe	
	57050	-	64000	No	USA - Canada	
	57000	-	64000	No	South Korea	
	59000	-	66000	No	Japan	
	59000	-	64000	No	China	
	59400	-	62900	No	Australia	

Table 6.105.3-3 lists the protected bands required for the dual connectivity configuration.

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Table 6.105.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_12A_n66A	Bands 2, 4, 5, 13, 14, 17, 24, 25, 26, 27, 29, 30, 41, 50, 51, 70, 71, n71, 74, n257	F_{DL_low}	-	F_{DL_high}	-50	1	
	Bands 4, 10, 48	F_{DL_low}	-	F_{DL_high}	-50	1	3
	Bands 12, 85	F_{DL_low}	-	F_{DL_high}	-50	1	4
NOTE 1: F_{DL_low} and F_{DL_high} refer to each E-UTRA frequency band specified in Table 5.5-1of TS 36.101 [2]. NOTE 2: F_{DL_low} and F_{DL_high} refer to each NR frequency band specified in Table 5.2-1 of TS 38.101-1 [3] and 38.101-2 [4]. NOTE 3: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.6.3.1-2 of TS 36.101 [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						

6.105.4 ΔT_{IB} and ΔR_{IB} values

For DC_12A_n66A, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are derived from LTE combination CA_12A-66A and are given in the tables below.

Table 6.105.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_12A_n66A	12	0.8
	n66	0.3

Table 6.105.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
DC_12A_n66A	12	0.5
	n66	0

6.105.5 REFSENS requirements

Table 6.105.5-1 lists the MSD required for the dual connectivity configuration due to 3rd harmonic of Band 12, reusing values specified in LTE for CA_12A-66A.

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Table 6.105.5-1: MSD due to 3rd harmonic issue for DC_12A-n66A

MSD due to harmonic exception for the DL band						
UL band	DL band	5 MHz	10 MHz	15 MHz	20 MHz	40 MHz
		dB	dB	dB	dB	dB
12	n66[1,2,3]	10	7.5	6.2	5.5	2.4

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 $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.3 \rfloor 0.1$ in MHz and $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$ 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.

NOTE 3: Applicable for the operations with 2 or 4 antenna ports supported in the band with carrier aggregation configured.

Table 6.105.5-2 Uplink configuration for the low band (exceptions due to harmonic issue)

E-UTRA Band / Channel bandwidth of the high band / N_{RB} / Duplex mode							
LTE-NR DC band combination	UL band	5 MHz	10 MHz	15 MHz	20 MHz	40 MHz	Duplex mode
DC_12A_n66A	12	8	16	20	20	20	FDD

6.105.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.105.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.105.6-1.

Table 6.105.6-1: Band 12 and Band n66 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_12A_n66A	12	a	3	b	0	3	n66	Harmonic
	n66	c	0	d	-1			

Equations (6.105.6-1) and (6.105.6-2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.105.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.105.6\text{-}1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.105.6\text{-}2)$$

Formula (3-1) and (3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.105.6\text{-}3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.105.6\text{-}3\text{-}2)$$

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6.106 DC_12A_n260A

6.106.1 Operating bands for DC

Table 6.106.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band Combination	E-UTRA and 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}	
DC_12A_n260A	12	699 MHz – 716 MHz	729 MHz – 746 MHz	FDD
	n260	37000 MHz – 40000 MHz	37000 MHz – 40000 MHz	TDD

6.106.2 Channel bandwidths per operating band for DC

Table 6.106.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and 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]
DC_12A_n260A	12	15	Yes	Yes										410 (210 for Band n260 with 60 kHz SCS)
	n260	60						Yes			Yes	Yes		
		120						Yes			Yes	Yes	Yes	
DC_12A_n260G	12	15	Yes	Yes										210
	n260	60	See CA_n260G Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_12A_n260H	12	15	Yes	Yes										310
	n260	60	See CA_n260H Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_12A_n260I	12	15	Yes	Yes										410
	n260	60	See CA_n260I Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_12A_n260J	12	15	Yes	Yes										510
	n260	60	See CA_n260J Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_12A_n260K	12	15	Yes	Yes										610
	n260	60	See CA_n260K Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_12A_n260L	12	15	Yes	Yes										710
	n260	60	See CA_n260L Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_12A_n260M	12	15	Yes	Yes										810
	n260	60	See CA_n260M Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_12A_n260(A-I)	12	15	Yes	Yes										810
	n260	60	See CA_n260(A-I) Bandwidth Combination in Table 5.5A.2-2 of TS 38.101-2											
		120												
DC_12A_n260(G-I)	12	15	Yes	Yes										610
	n260	60	See CA_n260(G-I) Bandwidth Combination in Table 5.5A.2-2 of TS 38.101-2											
		120												

6.106.3 Co-existence studies

Table 6.106.3-1 lists up to 7th harmonic and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 12+Band n260 2UL DC.

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Table 6.106.3-1: Band 12 and Band n260 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	619	716	37000	40000
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1398	1432	74000	80000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2097	2148	111000	120000
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	2796	2864	148000	160000
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	3095	3580	185000	200000
6th harmonics frequency limits	6*fx_low	6*fx_high	6* fy_low	6* fy_high
6th harmonics frequency limits (MHz)	3714	4296	222000	240000
7th harmonics frequency limits	7*fx_low	7*fx_high	7* fy_low	7* fy_high
7th harmonics frequency limits (MHz)	4333	5012	259000	280000
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	39301	36284	37699	40716
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)	38602	35568	73284	79301
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)	38398	41432	74699	80716
4rd 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)	78602	72568	75398	81432
4rd 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)	37903	34852	110284	119301
4rd 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)	39097	42148	111699	120716
5rd 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)	159301	147284	34136	37204
5rd 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)	148699	160716	39796	42864
5rd 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)	118602	109568	71852	77903
5rd 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)	112398	121432	76097	82148

Based on Table 6.106.3-1, it can be seen that

- 2nd order harmonic may fall into Rx frequencies of bands 50, 51, n75 and n76.
- 3rd order harmonic may fall into Rx frequencies of band 1, 4, 10, 65 or 66.
- 2nd 3rd 4th and 5th order IMD may fall into own Rx frequencies of band n260 (which can be disregarded, since no self-interference in TDD).

When 2UL inter-band EN-DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.106.3-2 lists up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.106.3-2: Band 12 and Band n260 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	
45GHz Unlicensed Bands	42300	-	47000	No	China	
	47200	-	48400	No	China	
60GHz Unlicensed Bands	57000	-	66000	No	Europe	
	57050	-	64000	No	USA - Canada	
	57000	-	64000	No	South Korea	
	59000	-	66000	No	Japan	
	59000	-	64000	No	China	
	59400	-	62900	No	Australia	

Table 6.106.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.106.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_12A_n260A	E-UTRA Band 2, 5, 13, 14, 17, 24, 25, 26, 30, 41, 48, 71	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 4, 66, 70	F_{DL_low}	-	F_{DL_high}	-50	1	2

NOTE 1: F_{DL_low} and F_{DL_high} refer to each E-UTRA frequency band specified in Table 5.5-1of TS 36.101 [2].
NOTE 2: F_{DL_low} and F_{DL_high} refer to each NR frequency band specified in Table 5.2-1 of TS 38.101-1 [3] and 38.101-2 [4].
NOTE 3: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.6.3.1-2 of TS 36.101 [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.

6.106.4 ΔT_{IB} and ΔR_{IB} values

For DC_12A_n260A, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are given in the tables below.

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Table 6.106.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_12A_n260A	12	0
	n260	0

Table 6.106.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
DC_12A_n260A	12	0
	n260	0

6.106.5 REFSENS requirements

No IMD issues are expected for DC configuration between the LTE bands below 6 GHz and FR2 NR band. Furthermore, up to 7th order harmonics have no impact to Rx frequency in either the LTE band or the NR band.

6.107 DC_20A-n77A

6.107.1 Operating bands for DC

Table 6.107.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_20A-n77A	20	832 MHz – 862 MHz	791 MHz – 821 MHz	FDD
	n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	TDD

6.107.2 Channel bandwidths per operating band for DC

Table 6.107.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_20A-n77A	20	15	Yes	Yes	Yes	Yes						120
	n77	15		Yes	Yes	Yes	Yes	Yes				
		30		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
		60		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

6.107.3 Co-existence studies

For 2UL/2DL UE coexistence study 2nd and 3rd order harmonics and 2nd, 3rd, 4th and 5th order intermodulation products were calculated and presented in Table 6.107.3-1

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Table 6.45.3-1: Harmonic and IMD analysis

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	832	862	3300	4200
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	1664	1724	6600	8400
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	2496	2586	9900	12600
Two tone 2nd order IMD products	|fy_low – fx_high|	|fy_high – fx_low|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	2438	3368	4132	5062
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)	2536	1576	5738	7568
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)	4964	5924	7432	9262
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)	1704	714	9038	11768
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)	5796	6786	10732	13462
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)	6736	4876	8264	10124
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)	15968	12338	148	872
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)	14032	17662	6628	7648
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)	10936	8176	4014	5904
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)	11564	14324	9096	10986

Based on the table 6.107.3-1, the 4th and 5th order IMD products may fall into the own Rx of Band 20, and 2nd and 5th order IMD may fall into the own RX of band n77. It should be noted that IMD will not be an issue for n77 (no self-interference) even through the IMD products may fall into the concerning band.

In addition, 3rd order harmonic and 2nd, 3rd, 4th and 5th IMD products may also fall into Rx frequencies of bands 1-14, 17-21, 23-31, 33-41, 44-70 and n77.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.107.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.45.3-2: 2UL Band x +Band y harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		IMD3, 4
Galileo	1559	-	1591	Yes		IMD3, 4
GLONASS	1591	-	1610	Yes		IMD3, 4
GPS	1563	-	1587	Yes		IMD3, 4
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	IMD 2, 3
	2400	-	2494	Yes	Asia	IMD 2, 3
ISM band (5GHz)	5150	-	5925	Yes	US	IMD3, 4, 5
	5150	-	5350	Yes	Europe	IMD3, 4, 5
	5470	-	5725	Yes		IMD3, 4, 5
	5150	-	5825	Yes	Asia	IMD3, 4, 5

Table 6.107.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.107.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_20A-n77A	E-UTRA Band 1, 3, 7, 8, 31, 32, 33, 34, 40, 50, 51, 65, 67, 68, 72, 74, 75, 76						
	E-UTRA Band 20	F_{DL_low}	-	F_{DL_high}	-50	1	15
	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 6.6.3.1-2 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 15: 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.							

6.107.4 ΔT_{IB} and ΔR_{IB} values

For DC_20A-n77A, the $\Delta T_{IB,c}$ and ΔR_{IB} values for DC_20A-n78A are reused.

Table 6.107.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_20A-n77A	20	0.6
	n77	0.8

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Table 6.107.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_20A-n77A	20	0
	n77	0.5

6.107.5 MSD

Based on the results in table 6.107.3-1, the 4th and 5th order IMD products may fall into the own Rx of Band 20.

Table 6.107.5-1 lists the MSD required for the dual connectivity configuration.

Table 6.107.5-1: MSD due to IMD issue for DC_20-n77A

E-UTRA Band / Channel bandwidth / N_{RB} / Duplex mode								Source of IMD
EUTRA/NR DC Configuration	EUTRA/NR band	UL F_c (MHz)	UL/DL BW (MHz)	UL C_{LRB}	DL F_c (MHz)	MSD (dB)	Duplex mode	
DC_20A-n77A	20	850	5	25	810	11	FDD	IMD4[4]
	n77	3360	10	50	3360	N/A	TDD	N/A
DC_20A-n78A	20	840	5	25	800	6.5	FDD	IMD5
	n77	4160	10	50	4150	N/A	TDD	N/A

The MSD level for Band n77 by 4th harmonic from Band 20 can reuse the value from LTE CA_20A-42A. Table 6.45.5-2 shows the MSD level for DC_20A-n77A. The MSD for 40MHz was calculated based on 20MHz, since the interference are same.

Table 6.107.5-2: MSD due to harmonic issue for DC_20-n77A

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
20	n77[1,2]		10.8	9.1	8		6				
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 4th 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 $f_{UL}^{LB} = \lfloor f_{DL}^{HB} / 0.4 \rfloor 0.1$ in MHz and $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$ 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.											

Regarding the uplink configuration, 40MHz for n77 should be considered additionally. Therefore, 20MHz with 100RB allocation for Band 20 should be added.

Table 6.107.5-3: Uplink configuration for the low band (exceptions) for E-UTRA

E-UTRA Band / Channel bandwidth of the high band / N_{RB} / Duplex mode									
LTE-NR DC band combination	UL band	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz	20 MHz	Duplex mode
DC_20A-n77A	20			8	16	25	25[1]	25[2]	FDD
NOTE 1: The configuration is used for measurement of MSD for NR channel bandwidth of 20MHz. NOTE 2: The configuration is used for measurement of MSD for NR channel bandwidth of 40MHz.									

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6.107.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.107.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.107.6-1.

Table 6.107.6-1: Band 20 and Band n77 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_20A_n77A	20	a	-3	b	-1	4	20	IMD
	n77	c	1	d	0			
DC_20A_n77A	20	a	-4	b	-1	5	20	IMD
	n77	c	1	d	0			
DC_20A_n77A	20	a	4	b	0	4	n77	Harmonic
	n77	c	0	d	-1			
DC_20A_n77A	20	a	5	b	0	5	n77	Harmonic
	n77	c	0	d	-1			

Equations (6.107.6-1) and (6.107.6-2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.107.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.107.6\text{-}1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.107.6\text{-}2)$$

Formula (3-1) and (3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.107.6\text{-}3\text{-}1)$$

$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.107.6\text{-}3\text{-}2)$$

6.108 DC_20A_n258A

6.108.1 Operating bands for DC

Table 6.108.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band	Downlink (DL) band	Duplex mode
		BS receive / UE transmit	BS transmit / UE receive	
		FUL_low – FUL_high	FDL_low – FDL_high	
DC_20A-n258A	20	832 MHz – 862 MHz	791 MHz – 821 MHz	TDD
	n258	24250 MHz – 27500 MHz	24250 MHz – 27500 MHz	TDD

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6.108.2 Channel bandwidths per operating band for DC

Table 6.108.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	50 MHz	100 MHz	[200 MHz]	400 MHz	Maximum aggregated bandwidth [MHz]
DC_20A-n258A	20	15	Yes	Yes	Yes	Yes					420
	n258	60					Yes	Yes	Yes		
		120					Yes	Yes	Yes	Yes	

6.108.3 Co-existence studies

The 2nd, 3rd and 4th IMD will be impact to the own received band n258. However, the NR TDD band has no impact from dual uplink transmission since there was no simultaneous Tx/Rx transmission in the band n258.

When 2UL inter-band DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.108.3-2 lists if up to 3rd order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.108.3-2: 2UL Band 20 +Band n258 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	

Table 6.108.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.108.3-3: Protected bands for the dual connectivity configuration

E-UTRA DC Configuration	Spurious emission					
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_20A_n258A	E-UTRA Band 1, 3, 7, 8, 22, 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 20	F_{DL_low}	-	F_{DL_high}	-50	1	1
	E-UTRA Band 38, 42, 52, 69	F_{DL_low}	-	F_{DL_high}	-50	1	2
	Frequency range	758	-	788	-50	1	

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NOTE 1: 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 of TS 36.101 [2] from the edge of the channel bandwidth.
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.

6.108.4 ΔT_{IB} and ΔR_{IB} values

For DC_20A-n258A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

Table 6.108.4-2: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_20A-n258A	20	0
	n258	0

Table 6.108.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_20A-n258A	20	0
	n258	0

6.108.5 MSD

From the coexistence analysis Table 6.108.1-1, there was no harmonic/IMD problem into own Rx of bands for DC_20A-n258A UE.

6.109 DC_30A_n5A

6.109.1 Operating bands for DC

Table 6.109.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band Combination	E-UTRA and 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}	
DC_30A_n5A	30	2305 MHz – 2315 MHz	2350 MHz – 2360 MHz	FDD
	n5	824 MHz – 849 MHz	869 MHz – 894 MHz	FDD

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6.109.2 Channel bandwidths per operating band for DC

Table 6.109.2-1 Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	**E-UTRA and NR Band**	**Subcarrier spacing [kHz]**	**5 MHz**	**10[1,2] MHz**	**15[2] MHz**	**20[2] MHz**	**25[2] MHz**	**30 MHz**	**40 MHz**	**50 MHz**	**60 MHz**	**80 MHz**	**100 MHz**	**Maximum aggregated bandwidth [MHz]**
DC_30A_n5A	30	15	Yes	Yes										30
	n5	15	Yes	Yes	Yes	Yes								
		30		Yes	Yes	Yes								
		60												
NOTE 1: 90% spectrum utilization may not be achieved for 30kHz SCS. NOTE 2: 90% spectrum utilization may not be achieved for 60kHz SCS. NOTE 3: This UE channel bandwidth is applicable only to downlink.														

6.109.3 Co-existence studies

Table 6.109.3-1 lists up to 7th harmonic and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 30+Band n5 2UL DC.

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Table 6.109.3-1: Band 30 and Band n5 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	824	849	2305	2315
2nd harmonics frequency limits	2* fy_low	2* fy_high	2*fx_low	2*fx_high
2nd harmonics frequency limits (MHz)	1648	1698	4610	4630
3rd harmonics frequency limits	3* fy_low	3* fy_high	3*fx_low	3*fx_high
3rd harmonics frequency limits (MHz)	2472	2547	6915	6945
4th harmonics frequency limits	4* fy_low	4* fy_high	4*fx_low	4*fx_high
4th harmonics frequency limits (MHz)	3296	3396	9220	9260
5th harmonics frequency limits	5* fy_low	5* fy_high	5*fx_low	5*fx_high
5th harmonics frequency limits (MHz)	4120	4245	11525	11575
6th harmonics frequency limits	6* fy_low	6* fy_high	6*fx_low	6*fx_high
6th harmonics frequency limits (MHz)	4944	5094	13830	13890
7th harmonics frequency limits	7* fy_low	7* fy_high	7*fx_low	7*fx_high
7th harmonics frequency limits (MHz)	5768	5943	16135	16205
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	1491	1456	3129	3164
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)	667	607	3761	3806
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)	3953	4013	5434	5479
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)	2982	2912	6258	6328
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)	157	242	6066	6121
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)	4777	4862	7739	7794
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)	8436	8371	1091	981
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)	10044	10109	5601	5711
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)	5297	5217	2063	2158
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)	8563	8643	7082	7177

Based on Table 6.109.3-1, it can be seen that

- 2nd order harmonic may fall into Rx frequencies of band 79.
- 3^{3d} order harmonic may fall into Rx frequencies of band 41.
- 2nd order IMD products may fall into Rx frequencies of band 11, 32, 45, 50, 74 and 75.
- 3^{3d} order IMD products may fall into Rx frequencies of bands 43, 46, 71, 77 and 78.
- 4th order IMD products may fall into Rx frequencies of band 79.
- 5th order IMD products may fall into Rx frequencies of bands 1, 4, 10, 46, 65 and 66.

It is concluded that there is no harmonic interference and IMD product falling into their own Rx bands.

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When 2UL inter-band EN-DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.109.3-2 lists up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.109.3-2: Band 30 and Band n5 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	3rd harmonic
	2400	-	2494	Yes	Asia	3rd harmonic
ISM band (5GHz)	5150	-	5925	Yes	US	3rd, 5th IMD
	5150	-	5350	Yes	Europe	5th IMD
	5470	-	5725	Yes		3rd, 5th IMD
	5150	-	5825	Yes	Asia	3rd, 5th IMD
45GHz Unlicensed Bands	42300	-	47000	No	China	
	47200	-	48400	No	China	
60GHz Unlicensed Bands	57000	-	66000	No	Europe	
	57050	-	64000	No	USA - Canada	
	57000	-	64000	No	South Korea	
	59000	-	66000	No	Japan	
	59000	-	64000	No	China	
	59400	-	62900	No	Australia	

Table 6.109.3-3 lists the protected bands required for the dual connectivity configuration.

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Table 6.109.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_30A_n5A	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	
	Band 26	859	-	869	-27	1	
	Bands 41, 48, 52	F_{DL_low}	-	F_{DL_high}	-50	1	3
	E-UTRA Band 18, 19	F_{DL_low}	-	F_{DL_high}	-40	1	5
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	5
	Frequency range	1884.5	-	1915.7	-41	0.3	4, 5

NOTE 1: F_{DL_low} and F_{DL_high} refer to each E-UTRA frequency band specified in Table 5.5-1of TS 36.101 [2].
NOTE 2: F_{DL_low} and F_{DL_high} refer to each NR frequency band specified in Table 5.2-1 of TS 38.101-1 [3] and 38.101-2 [4].
NOTE 3: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.6.3.1-2 of TS 36.101 [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: Applicable when co-existence with PHS system operating in 1884.5 -1915.7MHz.
NOTE 5: Applicable only when the assigned E-UTRA carrier is confined within 824 MHz and 849 MHz for UE category M1, M2 and UE category NB1 and NB2

6.109.4 ΔT_{IB} and ΔR_{IB} values

For DC_30A_n5A, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are derived from LTE combination CA_30A-5A and are given in the tables below.

Table 6.109.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_30A_n5A	30	0.3
	n5	0.3

Table 6.109.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
DC_30A_n5A	30	0
	n5	0

6.109.5 REFSENS requirements

Based on the findings in the co-existence studies in clause 6.109.3, no IMD issues are expected for this DC configuration.

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6.110 DC_30A_n66A

6.110.1 Operating bands for DC

Table 6.110.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band Combination	E-UTRA and 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}	
DC_30A_n66A	30	2305 MHz – 2315 MHz	2350 MHz – 2360 MHz	FDD
	n66	1710 MHz – 1780 MHz	2110 MHz – 2200 MHz	FDD

6.110.2 Channel bandwidths per operating band for DC

Table 6.110.2-1 Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10[1,2] MHz	15[2] MHz	20[2] MHz	25[2] MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Maximum aggregated bandwidth [MHz]
DC_30A_n66A	30	15	Yes	Yes										50
	n66	15	Yes	Yes	Yes	Yes			Yes					
		30		Yes	Yes	Yes			Yes					
		60		Yes	Yes	Yes			Yes					
NOTE 1: 90% spectrum utilization may not be achieved for 30kHz SCS. NOTE 2: 90% spectrum utilization may not be achieved for 60kHz SCS. NOTE 3: This UE channel bandwidth is applicable only to downlink.														

6.110.3 Co-existence studies

Table 6.110.3-1 lists up to 7th harmonic and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 30+Band n66 2UL DC.

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Table 6.110.3-1: Band 30 and Band n66 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	1710	1780	2305	2315
2nd harmonics frequency limits	2* fy_low	2* fy_high	2*fx_low	2*fx_high
2nd harmonics frequency limits (MHz)	3420	3560	4610	4630
3rd harmonics frequency limits	3* fy_low	3* fy_high	3*fx_low	3*fx_high
3rd harmonics frequency limits (MHz)	5130	5340	6915	6945
4th harmonics frequency limits	4* fy_low	4* fy_high	4*fx_low	4*fx_high
4th harmonics frequency limits (MHz)	6840	7120	9220	9260
5th harmonics frequency limits	5* fy_low	5* fy_high	5*fx_low	5*fx_high
5th harmonics frequency limits (MHz)	8550	8900	11525	11575
6th harmonics frequency limits	6* fy_low	6* fy_high	6*fx_low	6*fx_high
6th harmonics frequency limits (MHz)	10260	10680	13830	13890
7th harmonics frequency limits	7* fy_low	7* fy_high	7*fx_low	7*fx_high
7th harmonics frequency limits (MHz)	11970	12460	16135	16205
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	605	525	4015	4095
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)	1105	1255	2830	2920
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)	5725	5875	6320	6410
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)	1210	1050	8030	8190
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)	2815	3035	5135	5235
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)	7435	7655	8625	8725
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)	7550	7440	4815	4525
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)	10930	11040	9145	9435
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)	3525	3355	730	500
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)	10335	10505	9740	9970

Based on Table 6.110.3-1, it can be seen that

- 2nd order harmonic may fall into Rx frequencies of bands 22, 42, 48, 49, 77, 78 or 79.
- 3^{3d} order harmonic may fall into Rx frequencies of band 46.
- 2nd order IMD products may fall into Rx frequencies of band 77
- 3^{3d} order IMD products may fall into Rx frequencies of bands 46 or 47
- 4th order IMD products may fall into Rx frequencies of band 46.
- 5th order IMD products may fall into Rx frequencies of bands 12, 22, 29, 42, 44, 71, 77, 78 or 79.

When 2UL inter-band EN-DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.110.3-2 lists up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.110.3-2: Band 30 and Band n66 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	Yes	US	3rd, 4th IMD 3rd harmonic
	5150	-	5350	Yes	Europe	4th IMD 3rd harmonic
	5470	-	5725	Yes		3rd IMD
	5150	-	5825	Yes	Asia	3rd, 4th IMD 3rd harmonic
45GHz Unlicensed Bands	42300	-	47000	No	China	
	47200	-	48400	No	China	
60GHz Unlicensed Bands	57000	-	66000	No	Europe	
	57050	-	64000	No	USA - Canada	
	57000	-	64000	No	South Korea	
	59000	-	66000	No	Japan	
	59000	-	64000	No	China	
	59400	-	62900	No	Australia	

Table 6.110.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.110.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_30A_n66A	Bands 2, 4, 5, 10, 12, 13, 14, 17, 24, 25, 26, 27, 29, 30, 38, 41, 66, 70, 71, n71, n257	F_{DL_low}	-	F_{DL_high}	-50	1	
	Bands 48	F_{DL_low}	-	F_{DL_high}	-50	1	3

NOTE 1: F_{DL_low} and F_{DL_high} refer to each E-UTRA frequency band specified in Table 5.5-1of TS 36.101 [2].
NOTE 2: F_{DL_low} and F_{DL_high} refer to each NR frequency band specified in Table 5.2-1 of TS 38.101-1 [3] and 38.101-2 [4].
NOTE 3: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.6.3.1-2 of TS 36.101 [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.

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6.110.4 ΔT_{IB} and ΔR_{IB} values

For DC_30A_n66A, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are derived from LTE combination CA_30A-66A and are given in the tables below.

Table 6.110.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_30A_n66A	30	0.5
	n66	0.8

Table 6.110.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
DC_30A_n66A	30	0.5
	n66	0.4

6.110.5 REFSENS requirements

Referring to DC_1A_n40A, according to TS 36.101 in table 7.3.1A-0bE, there is a cross band isolation issue for DC_30A_n66A. The MSD for DC_30A_n66A is shown as below.

Table 6.110.5-1: Reference sensitivity exceptions (MSD) due to cross band isolation for EN-DC in NR FR1

	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)
30	n66	8.3	8.3	8.3	8.3			8.3					

Table 6.110.5-2: Uplink configuration for reference sensitivity exceptions due to cross band isolation for EN-DC in NR FR1

E-UTRA or NR Band / SCS / Channel bandwidth of the affected DL band / UL RB allocation of the agressor band														
UL band	DL band	SCS of UL band (kHz)	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})	80 MHz (L_{CRB})	90 MHz (L_{CRB})	100 MHz (L_{CRB})
30	n66	15	25	25	25	25			25					

6.111 DC_30A_n260A

6.111.1 Operating bands for DC

Table 6.111.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band Combination	E-UTRA and 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}	
DC_30A_n260A	30	2305 MHz – 2315 MHz	2350 MHz – 2360 MHz	FDD
	n260	37000 MHz – 40000 MHz	37000 MHz – 40000 MHz	TDD

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6.111.2 Channel bandwidths per operating band for DC

Table 6.111.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	**E-UTRA and 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]**
DC_30A_n260A	30	15	Yes	Yes										410 (210 for Band n260 with 60 kHz SCS)
	n260	60						Yes			Yes	Yes		
		120						Yes			Yes	Yes	Yes	
DC_30A_n260G	30	15	Yes	Yes										210
	n260	60	See CA_n260G Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_30A_n260H	30	15	Yes	Yes										310
	n260	60	See CA_n260H Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_30A_n260I	30	15	Yes	Yes										410
	n260	60	See CA_n260I Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_30A_n260J	30	15	Yes	Yes										510
	n260	60	See CA_n260J Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_30A_n260K	30	15	Yes	Yes										610
	n260	60	See CA_n260K Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_30A_n260L	30	15	Yes	Yes										710
	n260	60	See CA_n260L Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_30A_n260M	30	15	Yes	Yes										810
	n260	60	See CA_n260M Bandwidth Combination Fall-back Group 3 in Table 5.5A.1-1 in TS 38.101-2											
		120												
DC_30A_n260(A-I)	30	15	Yes	Yes										810
	n260	60	See CA_n260(A-I) Bandwidth Combination in Table 5.5A.2-2 of TS 38.101-2											
		120												
DC_30A_n260(G-I)	30	15	Yes	Yes										610
	n260	60	See CA_n260(G-I) Bandwidth Combination in Table 5.5A.2-2 of TS 38.101-2											
		120												

6.111.3 Co-existence studies

Table 6.111.3-1 lists up to 7th harmonic and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 30+Band n260 2UL DC.

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Table 6.111.3-1: Band 30 and Band n260 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	2305	2315	37000	40000
2nd harmonics frequency limits	2*fx_low	2*fx_high	2* fy_low	2* fy_high
2nd harmonics frequency limits (MHz)	4610	4630	74000	80000
3rd harmonics frequency limits	3*fx_low	3*fx_high	3* fy_low	3* fy_high
3rd harmonics frequency limits (MHz)	6915	6945	111000	120000
4th harmonics frequency limits	4*fx_low	4*fx_high	4* fy_low	4* fy_high
4th harmonics frequency limits (MHz)	9220	9260	148000	160000
5th harmonics frequency limits	5*fx_low	5*fx_high	5* fy_low	5* fy_high
5th harmonics frequency limits (MHz)	11525	11575	185000	200000
6th harmonics frequency limits	6*fx_low	6*fx_high	6* fy_low	6* fy_high
6th harmonics frequency limits (MHz)	13830	13890	222000	240000
7th harmonics frequency limits	7*fx_low	7*fx_high	7* fy_low	7* fy_high
7th harmonics frequency limits (MHz)	16135	16205	259000	280000
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	37695	34685	39305	42315
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)	35390	32370	71685	77695
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)	41610	44630	76305	82315
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)	75390	69370	78610	84630
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)	33085	30055	108685	117695
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)	43915	46945	113305	122315
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)	157695	145685	27740	30780
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)	150305	162315	46220	49260
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)	115390	106370	67055	73085
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)	115610	124630	80915	86945

Based on Table 6.111.3-1, it can be seen that

- 2nd order harmonic may fall into Rx frequencies of band n79.
- 2nd order IMD may fall into own Rx frequencies of band n260 (which can be disregarded, since no self-interference in TDD).
- 4th order IMD may fall into band n259.
- 5th order IMD may fall into band n257.

When 2UL inter-band EN-DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.111.3-2 lists up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

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Table 6.111.3-2: Band 30 and Band n260 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	No		
Galileo	1559	-	1591	No		
GLONASS	1591	-	1610	No		
GPS	1563	-	1587	No		
ISM band (2.4GHz)	2400	-	2483.5	No	US/Europe	
	2400	-	2494	No	Asia	
ISM band (5GHz)	5150	-	5925	No	US	
	5150	-	5350	No	Europe	
	5470	-	5725	No		
	5150	-	5825	No	Asia	
45GHz Unlicensed Bands	42300	-	47000	Yes	China	3rd IMD
	47200	-	48400	Yes	China	5th IMD
60GHz Unlicensed Bands	57000	-	66000	No	Europe	
	57050	-	64000	No	USA - Canada	
	57000	-	64000	No	South Korea	
	59000	-	66000	No	Japan	
	59000	-	64000	No	China	
	59400	-	62900	No	Australia	

Table 6.111.3-3 lists the protected bands required for the dual connectivity configuration.

Table 6.111.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_30A_n260A	E-UTRA Band 2, 4, 5, 12, 13, 14, 17, 24, 25, 26, 29, 41, 48, 66, 70, 71	F_{DL_low}	-	F_{DL_high}	-50	1	
NOTE 1: F_{DL_low} and F_{DL_high} refer to each E-UTRA frequency band specified in Table 5.5-1of TS 36.101 [2].							
NOTE 2: F_{DL_low} and F_{DL_high} refer to each NR frequency band specified in Table 5.2-1 of TS 38.101-1 [3] and 38.101-2 [4].							
NOTE 3: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.6.3.1-2 of TS 36.101 [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.							

6.111.4 ΔT_{IB} and ΔR_{IB} values

For DC_30A_n260A, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are given in the tables below.

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Table 6.111.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_30A_n260A	30	0
	n260	0

Table 6.111.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
DC_30A_n260A	30	0
	n260	0

6.111.5 REFSENS requirements

No IMD issues are expected for DC configuration between the LTE bands below 6 GHz and FR2 NR band. Furthermore, up to 7th order harmonics have no impact to Rx frequency in either the LTE band or the NR band.

6.112 DC_40A-n77A

6.112.1 Operating bands for DC

Table 6.112.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and 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}	
DC_40A-n77A	40	2300 MHz – 2400 MHz	2300 MHz – 2400 MHz	TDD
	n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	TDD

6.112.2 Channel bandwidths per operating band for DC

Table 6.112.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_40A-n77A	40	15	Yes	Yes	Yes	Yes						120
	n77	15		Yes	Yes	Yes	Yes	Yes				
		30		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
		60		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

6.112.3 Co-existence studies

Since simultaneous Rx/Tx transmission are not supported, at least in Rel-15, co-existence studies are not needed.

6.112.4 ΔT_{IB} and ΔR_{IB} values

For DC_40A-n77A, the $\Delta T_{IB,c}$ and ΔR_{IB} values for LTE CA_40A-42A are reused.

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Table 6.112.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_40A-n77A	40	0
	n77	0.5

Table 6.112.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_40A-n77A	40	0.4
	n77	0.5

6.112.5 MSD

There is no MSD issue for this DC configuration based on that simultaneous Rx/Tx transmission are not supported at least in Rel-15.

6.113 DC_66A_n5A

6.113.1 Operating bands for DC

Table 6.113.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band Combination	E-UTRA and 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}	
DC_66A_n5A	66	1710 MHz – 1780 MHz	2110 MHz – 2200 MHz	FDD
	n5	824 MHz – 849 MHz	869 MHz – 894 MHz	FDD

6.113.2 Channel bandwidths per operating band for DC

Table 6.113.2-1 Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth														
E-UTRA and NR DC Configuration	E-UTRA and NR Band	Subcarrier spacing [kHz]	5 MHz	10[1,2] MHz	15[2] MHz	20[2] MHz	25[2] MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	100 MHz	Maximum aggregated bandwidth [MHz]
DC_66A_n5A	66	15	Yes	Yes	Yes	Yes								40
	n5	15	Yes	Yes	Yes	Yes								
		30		Yes	Yes	Yes								
		60												
NOTE 1: 90% spectrum utilization may not be achieved for 30kHz SCS. NOTE 2: 90% spectrum utilization may not be achieved for 60kHz SCS. NOTE 3: This UE channel bandwidth is applicable only to downlink.														

6.113.3 Co-existence studies

Table 6.113.3-1 lists up to 7th harmonic and 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis for Band 66+Band n5 2UL DC.

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Table 6.113.3-1: Band 66 and Band n5 UL harmonics and IMD products

UE UL carriers	fx_low	fx_high	fy_low	fy_high
UL frequency (MHz)	824	849	1710	1780
2nd harmonics frequency limits	2* fy_low	2* fy_high	2*fx_low	2*fx_high
2nd harmonics frequency limits (MHz)	1648	1698	3420	3560
3rd harmonics frequency limits	3* fy_low	3* fy_high	3*fx_low	3*fx_high
3rd harmonics frequency limits (MHz)	2472	2547	5130	5340
4th harmonics frequency limits	4* fy_low	4* fy_high	4*fx_low	4*fx_high
4th harmonics frequency limits (MHz)	3296	3396	6840	7120
5th harmonics frequency limits	5* fy_low	5* fy_high	5*fx_low	5*fx_high
5th harmonics frequency limits (MHz)	4120	4245	8550	8900
6th harmonics frequency limits	6* fy_low	6* fy_high	6*fx_low	6*fx_high
6th harmonics frequency limits (MHz)	4944	5094	10260	10680
7th harmonics frequency limits	7* fy_low	7* fy_high	7*fx_low	7*fx_high
7th harmonics frequency limits (MHz)	5768	5943	11970	12460
2nd order IMD products	|fy_high – fx_low|	|fy_low – fx_high|	|fy_low + fx_low|	|fy_high + fx_high|
IMD frequency limits (MHz)	1491	1456	3129	3164
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)	667	607	3761	3806
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)	3953	4013	5434	5479
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)	2982	2912	6258	6328
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)	157	242	6066	6121
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)	4777	4862	7739	7794
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)	8436	8371	1091	981
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)	10044	10109	5601	5711
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)	5297	5217	2063	2158
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)	8563	8643	7082	7177

Based on Table 6.113.3-1, it can be seen that

- 2nd order harmonic may fall into Rx frequencies of bands 22, 42, 48, 49, 77 and 78.
- 3[3d] order harmonic may fall into Rx frequencies of bands 41 and 46.
- 2nd order IMD products may fall into Rx frequencies of bands 6, 7, 8, 18, 19, 26, 27, 38, 41 and 69, or its own RX frequency in band 5.
- 3[3d] order IMD products may fall into Rx frequencies of bands 7, 38, 41, 42, 69, 77, 78 and 79.
- 4th order IMD products may fall into Rx frequencies of bands 3, 9, 12, 13, 17, 20, 28, 29, 33, 35, 37, 39, 44, 46, 67, 68, 77 and 79.
- 5th order IMD products may fall into Rx frequencies of bands 6, 8, 18, 19, 22, 24, 26, 42, 43, 46, 47, 48, 49, 50, 74, 75, 77 and 78, or its own RX frequency in band 5.

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When 2UL inter-band EN-DC UE is operating with other systems such as WiFi, Bluetooth and GNSS system, the harmonics and intermodulation products can have impact on these systems. Table 6.113.3-2 lists up to 7th order harmonics and IMD up to 5th order falls into one of these receiving bands.

Table 6.113.3-2: Band 66 and Band n5 harmonic and IMD for ISM and GNSS bands

Victim Systems	Frequency range [MHz]			Impact	Regions	Comments
COMPASS (Beidou)	1559	-	1591	Yes		5th IMD
Galileo	1559	-	1591	Yes		5th IMD
GLONASS	1591	-	1610	Yes		5th IMD
GPS	1563	-	1587	Yes		5th IMD
ISM band (2.4GHz)	2400	-	2483.5	Yes	US/Europe	3rd harmonic
	2400	-	2494	Yes	Asia	3rd harmonic
ISM band (5GHz)	5150	-	5925	Yes	US	4th, 5th IMD 3rd harmonic
	5150	-	5350	Yes	Europe	4th, 5th IMD 3rd harmonic
	5470	-	5725	No		
	5150	-	5825	Yes	Asia	4th, 5th IMD 3rd harmonic
45GHz Unlicensed Bands	42300	-	47000	No	China	
	47200	-	48400	No	China	
60GHz Unlicensed Bands	57000	-	66000	No	Europe	
	57050	-	64000	No	USA - Canada	
	57000	-	64000	No	South Korea	
	59000	-	66000	No	Japan	
	59000	-	64000	No	China	
	59400	-	62900	No	Australia	

Table 6.113.3-3 lists the protected bands required for the dual connectivity configuration.

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Table 6.113.3-3: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_66A_n5A	Bands 1, 2, 3, 4, 5, 6, 7, 8, 10, 12, 13, 14, 17, 24, 25, 28, 29, 30, 34, 38, 40, 43, 45, 50, 51, 65, 66, 70, 71, n71, 85, n257	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 26	859	-	869	-27	1	
	Bands 41, 42, 48, 52	F_{DL_low}	-	F_{DL_high}	-50	1	3
	E-UTRA Band 18, 19	F_{DL_low}	-	F_{DL_high}	-40	1	5
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	5
	Frequency range	1884.5	-	1915.7	-41	0.3	4, 5

NOTE 1: F_{DL_low} and F_{DL_high} refer to each E-UTRA frequency band specified in Table 5.5-1of TS 36.101 [2].
NOTE 2: F_{DL_low} and F_{DL_high} refer to each NR frequency band specified in Table 5.2-1 of TS 38.101-1 [3] and 38.101-2 [4].
NOTE 3: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.6.3.1-2 of TS 36.101 [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: Applicable when co-existence with PHS system operating in 1884.5 -1915.7MHz.
NOTE 5: Applicable only when the assigned E-UTRA carrier is confined within 824 MHz and 849 MHz for UE category M1, M2 and UE category NB1 and NB2

6.113.4 ΔT_{IB} and ΔR_{IB} values

For DC_66A_n5A, the $\Delta T_{IB,c}$ and $\Delta R_{IB,c}$ values are derived from LTE combination CA_66A-5A and are given in the tables below.

Table 6.113.4-1: $\Delta T_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_66A_n5A	66	0.3
	n5	0.3

Table 6.113.4-2: $\Delta R_{IB,c}$

E-UTRA and NR DC Configuration	E-UTRA and NR Band	$\Delta R_{IB,c}$ [dB]
DC_66A_n5A	66	0
	n5	0

6.113.5 REFSENS requirements

Due to 2nd order IMD MSD are needed and are defined in table 6.113.5-1 Values are reused from existing LTE combination CA_5A-66A.

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Table 6.113.5-1: Reference sensitivity exceptions due to dual uplink operation for EN-DC in NR FR1 (two bands)

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)	Duplex mode	IMD order	Single UL allowed
DC_66A_n5A	n5	838	5	25	883	30	FDD	IMD2[1]	
	66	1721	5	25	2121	N/A		N/A	
NOTE 1: This band is subject to IMD5 also which MSD is not specified.									

6.113.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.113.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.113.6-1.

Table 6.113.6-1: Band 66 and Band n5 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_66A_n5A	n5	a	-1	b	-1	2	n5	IMD
	66	c	1	d	0			
DC_66A_n5A	n5	a	-3	b	-1	5	n5	IMD
	66	c	2	d	0			

Equations (6.113.6-1) and (6.113.6-2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.113.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.113.6\text{-}1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.113.6\text{-}2)$$

Formula (6.113.6-3-1) and (6.113.6-3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.113.6\text{-}3\text{-}1)$$

$$|f_{INT}| < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.113.6\text{-}3\text{-}2)$$

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6.114 DC_66A_n78A

6.114.1 Operating bands for DC

Table 6.114.1-1: DC band combination of LTE 1DL/1UL + one NR band

E-UTRA and NR DC Band	E-UTRA and NR Band	Uplink (UL) band	Downlink (DL) band	Duplex mode
		BS receive / UE transmit	BS transmit / UE receive	
		FUL_low – FUL_high	FDL_low – FDL_high	
DC_66-n78	66	1710 MHz – 1780 MHz	2110 MHz – 2220 MHz	FDD
	n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD

6.114.2 Channel bandwidths per operating band for DC

Table 6.114.2-1: Supported bandwidths per DC band combination of LTE 1DL/1UL + one NR band

DC operating / channel bandwidth												
E-UTRA and NR DC Configuration	E-UTRA and NR 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]
DC_66A-n78A	66	15	Yes	Yes	Yes	Yes						120
	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	

6.114.3 Co-existence studies

Table 6.114.3-1 provides the self-interference study for DC_66A_n78A.

Table 6.114.3-1: Harmonics and IMD products

E-UTRA and NR DC Configuration	E-UTRA and NR Band	DL frequency range (MHz)	Rx Impact	Harmonic/IMD orders	Notes
DC_66A-n78A	66	2110 MHz -2220 MHz	Yes	IMD5	
	n78	3300 MHz -3800 MHz	Yes	2th Harmonic	

Table 6.114.3-2 lists the protected bands required for the dual connectivity configuration.

Table 6.114.3-2: Protected bands for the dual connectivity configuration

E-UTRA and NR DC Combination	Spurious emission					
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
DC_66_n78	E-UTRA Band 1, 3, 5, 7, 8, 20, 26, 28, 34, 39, 40, 41, 65	F_{DL_low}	-	F_{DL_high}	-50	1	

6.114.4 ΔT_{IB} and ΔR_{IB} values

For DC_66A-n78A, the $\Delta T_{IB,c}$ and ΔR_{IB} values are given in the tables below.

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Table 6.114.4-1: $\Delta T_{IB,c}$

Inter-band DC Configuration	E-UTRA and NR Band	$\Delta T_{IB,c}$ [dB]
DC_66A-n78A	66	0.6
	n78	0.8
NOTE 1: HTF is assumed for Band 66.		

Table 6.114.4-2: ΔR_{IB}

Inter-band DC Configuration	E-UTRA and NR Band	ΔR_{IB} [dB]
DC_66A-n78A	66	0.2
	n78	0.5
NOTE 1: HTF is assumed for Band 66.		

6.114.5 MSD

MSD values for Band n78 due to 2nd harmonic of Band 66 for DC_66A-n78A are captured in Table 6.114.5-1 with the uplink configuration in Table 6.114.5-2.

Table 6.114.5-1: MSD due to harmonic issue for DC_66A-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**
66	n78[1,2]		23.9	22.1	20.9		17.9				
	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.

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 $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$ 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 $2 f_{UL}^{LB}$ in the victim (higher band) with $F_{UL\_low}^{LB} + BW_{Channel}^{LB} / 2 \le f_{UL}^{LB} \le F_{UL\_high}^{LB} - BW_{Channel}^{LB} / 2$, 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 6.114.5-2 Uplink configuration for the low band (exceptions)

E-UTRA Band / Channel bandwidth of the high band / N_{RB} / Duplex mode									
LTE-NR DC band combination	**UL band**	**1.4 MHz**	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**40 MHz**	**Duplex mode**
DC_66-n78	66				26	39	53	100	FDD

MSD for IMD5 is less than 2dB based on the analysis, so the MSD requirement is not needed to be defined for these band combination.

Table 6.114.5-3: Void

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6.114.6 Self-interference analysis

This section provides the formulation to determine whether the DL carriers would be impacted by UL harmonics, 2UL inter-modulation products (IMD), or DL harmonic mixing with UL interferer based on UL and DL channel combinations. The potential self-interference mechanism has been identified in section 6.114.3 co-existence studies except for harmonic mixing which are used to generate an interference mixing coefficient table for this DC combination, as shown in Table 6.114.6-1.

Table 6.114.6-1: Band 66 and Band n78 interference mixing coefficients

EUTRA-NR DC Configuration	EUTRA/NR Band	UL Coefficient		DL Coefficient		Harmonic/IMD Order	Victim Band	Interference Type
DC_66A_n78A	66	a	-3	b	-1	5	66	IMD
	n78	c	2	d	0			
DC_66A_n78A	66	a	2	b	0	2	n78	Harmonic
	n78	c	0	d	-1			

Equations (6.114.6-1) and (6.114.6-2) below are used to calculate the interference center frequency (f_{INT}) and its effective bandwidth (BW_{INT}) where coefficients a, b, c, and d are defined in Table 6.114.6-1 and *CBW* stands for channel bandwidth.

$$f_{INT} = a \times f_{TX1} + b \times f_{RX1} + c \times f_{TX2} + d \times f_{RX2} \quad (6.114.6\text{-}1)$$

$$BW_{INT} = a \times CBW_{TX1} + c \times CBW_{TX2} \quad (6.114.6\text{-}2)$$

Formula (6.114.6-3-1) and (6.114.6-3-2) below are then used to indicate when the interference is overlapping with *RX1* and *RX2*, respectively.

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX1}}{2} \quad (6.114.6\text{-}3\text{-}1)$$

$$| f_{INT} | < \frac{BW_{INT} + CBW_{RX2}}{2} \quad (6.114.6\text{-}3\text{-}2)$$

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Annex A:
Change history

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2017-08	RAN4#84	R4-1707513				Initial TR skeleton	0.0.1
2017-09	RAN4 NR#3	R4-1709388				TR 37.863-01-01_V0.1.0_Rel15_DC band combinations of LTE 1DL1UL + one NR band	0.1.0
		R4-1707189				TP for TR 37.863-01-01: Dual connectivity (DC) band combinations of LTE 1DL/1UL + one NR band	
		R4-1707190				TP for TR 37.863-01-01: Dual connectivity (DC) band combinations of LTE 1DL/1UL + one NR band	
		R4-1707209				TP for TR 37.863-01-01: Dual connectivity (DC) band combinations of LTE 1DL/1UL + one NR band	
		R4-1707210				TP for TR 37.863-01-01: Dual connectivity (DC) band combinations of LTE 1DL/1UL + one NR band	
		R4-1707211				TP for TR 37.863-01-01: Dual connectivity (DC) band combinations of LTE 1DL/1UL + one NR band	
		R4-1707213				TP for TR 37.863-01-01: Dual connectivity (DC) band combinations of LTE 1DL/1UL + one NR band	
		R4-1707234				TP for TR 37.863-01-01: Dual connectivity (DC) band combinations of LTE 1DL/1UL + one NR band	
		R4-1707252				TP for TR 37.863-01-01: Dual connectivity (DC) band combinations of LTE 1DL/1UL + one NR band	
		R4-1707278				TP for TR 37.863-01-01: Dual connectivity (DC) band combinations of LTE 1DL/1UL + one NR band	
		R4-1707279				TP for TR 37.863-01-01: Dual connectivity (DC) band combinations of LTE 1DL/1UL + one NR band	
		R4-1708066				TP for TR 37.863-01-01 operating bands, channel bandwidths for 2DL2UL DC_28A-xA_BCS0	
		R4-1708068				TP for TR 37.863-01-01 operating bands, channel bandwidths for 2DL2UL DC_28A-yA_BCS0	
		R4-1708416				TP for TR 37.863-01-01: operating bands and channel bandwidths for DC_1A-n78A_BCS0	
		R4-1708418				TP for TR 37.863-01-01: operating bands and channel bandwidths for DC_3A-n78A_BCS0	
		R4-1708840				TP for TR 37.863-01-01: DC band combination of LTE Band 20 + NR Band 28	
		R4-1708894				TP for TR 37.863-01-01: 2DL/2UL DC_1A-n79A_BCS0	
		R4-1708895				TP for TR 37.863-01-01: 2DL/2UL DC_3A-n79A_BCS0	
		R4-1708896				TP for TR 37.863-01-01: 2DL/2UL DC_19A-n79A_BCS0	
		R4-1708897				TP for TR 37.863-01-01: 2DL/2UL DC_21A-n79A_BCS0	
		R4-1708898				TP for TR 37.863-01-01: 2DL/2UL DC_28A-n79A_BCS0	
		R4-1708899				TP for TR 37.863-01-01: 2DL/2UL DC_42A-n79A_BCS0	
		R4-1708967				TP for TR 37.863-01-01: Dual connectivity (DC) band combinations of LTE 1DL/1UL + one NR band	
		R4-1708968				TP for TR 37.863-01-01: Dual connectivity (DC) band combinations of LTE 1DL/1UL + one NR band	
		R4-1708969				TP for TR 37.863-01-01: Dual connectivity (DC) band combinations of LTE 1DL/1UL + one NR band	
		R4-1708974				TP for TR 37.863-01-01 DC_1A-n77A	
		R4-1708975				TP for TR 37.863-01-01 DC_3A-n77A	
		R4-1708976				TP for TR 37.863-01-01 DC_19A-n77A	
		R4-1708977				TP for TR 37.863-01-01 DC_19A-n78A	
		R4-1708978				TP for TR 37.863-01-01: co-existence studies, UE requirements relaxation for 2DL/2UL DC_28A-xA_BCS0	
		R4-1708979				TP for TR 37.863-01-01: co-existence studies, UE requirements relaxation for 2DL/2UL DC_28A-yA_BCS0	
		R4-1708980				TP for TR 37.863-01-01: co-existence studies and MDS for DC_3A-n78A_BCS0	
		R4-1708981				TP for TR 37.863-01-01 co-existence study for DC_39A-n78A_BCS0	
		R4-1708982				TP for TR 37.863-01-01 co-existence study for DC_39A-n258A_BCS0	
		R4-1708983				TP for TR 37.863-01-01: co-existence studies and MSD for DC_1A-n78A_BCS0	
		R4-1708987				TP for TR 37.863-01-01 DC_21A-n77A	

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		R4-1708988				TP for TR 37.863-01-01 DC_21A-n78A	
		R4-1708989				TP for TR 37.863-01-01 DC_42A-n77A	
		R4-1708990				TP for TR 37.863-01-01 DC_42A-n78A	
2017-10	3GPP RAN4#84bis	R4-1711073				TR 37.863-01-01_V0.2.0_Rel15_DC band combinations of LTE 1DL1UL + one NR band	0.2.0
		R4-1709390				Feasibility of DC_42A-n77A and 42A-n78A	
		R4-1709434				TP for TR 37.863-01-01 co-existence study for DC_39A-n79A_BCS0	
		R4-1709435				TP for TR 37.863-01-01 co-existence study for DC_41A-n78A_BCS0	
		R4-1709436				TP for TR 37.863-01-01 co-existence study for DC_41A-n79A_BCS0	
		R4-1709437				TP for TR 37.863-01-01 co-existence study for DC_41A-n258A_BCS0	
		R4-1709438				TP for TR 37.863-01-01 co-existence study for DC_41A-n77A_BCS0	
		R4-1709490				TP for TR 37.863-01-01 for DC_3A-n258A	
		R4-1709491				TP for TR 37.863-01-01 for DC_7A-n258A	
		R4-1709492				TP for TR 37.863-01-01 for DC_28A-n258A	
		R4-1709507				TP for TR 37.863-01-01: Operating bands, Channel bandwidths for DC_8A-n79A	
		R4-1709510				TP for TR 37.863-01-01: Co-existence studies and MSD for DC_8A-n79A	
		R4-1709511				TP for TR 37.863-01-01: Operating bands,Channel bandwidths for DC_8A-n78A	
		R4-1709512				TP for TR 37.863-01-01: Operating bands, Channel bandwidths for DC_8A-n258A	
		R4-1709523				TP for TR 37.863-01-01:Co-existence studies and MSD for DC_8A-n78A	
		R4-1709524				TP for TR 37.863-01-01: Co-existence studies and MSD for DC_8A-n258A	
		R4-1709577				TP on TR37.863-01-01 for DC_7A-n78A	
		R4-1709593				TP for TR 37.863-01-01: DC band combination of LTE Band 38 and NR Band n78	
		R4-1709660				TP for TR 37.863-01-01 operating bands, channel bandwidths for 2DL2UL DC_20A-n78A_BCS0	
		R4-1709661				TP for TR 37.863-01-01 co-existence studies, UE requirements relaxation for 2DL2UL DC_20A-n78A_BCS0	
		R4-1709680				TP for TR 37.863-01-01 DC_5A-n257A	
		R4-1709759				TP for TR 37.863-01-01 DC_1A_n257	
		R4-1709760				TP for TR 37.863-01-01 DC_3A_n257	
		R4-1709761				TP for TR 37.863-01-01 DC_19A_n257	
		R4-1709762				TP for TR 37.863-01-01 DC_21A_n257	
		R4-1709763				TP for TR 37.863-01-01 DC_28A_n257	
		R4-1709764				TP for TR 37.863-01-01 DC_42A_n257	
		R4-1710032				TP for TR 37.863-01-01: DC band combination of LTE Band 20 and NR Band n28	
2017-10	RAN4#85	R4-1712817				TR 37.863-01-01_V0.3.0_Rel15_DC band combinations of LTE 1DL1UL + one NR band	0.3.0
		R4-1710574				TP for TR 37.863-01-01 for DC_5A-n78A	
		R4-1710694				TP for TR 37.863-01-01 DC_5A-n78A	
		R4-1710695				TP for TR 37.863-01-01 DC_7A-n257A	
		R4-1710710				TP on UE RF architectures for NSA DC UE	
		R4-1710773				TP for TR 37.863-01-01 DC_3A_n7	
		R4-1710850				TP for TR 37.863-01-01 DC_66A-n257A	
		R4-1710893				TP for TR 37.863-01-01 self-interference analysis for DC_18A_n77	
		R4-1710894				TP for TR 37.863-01-01 self-interference analysis for DC_19A_n77	
		R4-1710895				TP for TR 37.863-01-01 self-interference analysis for DC_26A_n77	
		R4-1710948				TP for TR 37.863-01-01: MSD for DC_18A-n77A	
		R4-1710949				TP for TR 37.863-01-01: MSD for DC_18A-n78A	
		R4-1711072				TP for TR 37.863-01-01 Delta values for DC combinations including Band n77, n78, n79 and n257	
		R4-1711091				TP for TR 37.863-01-01: DC band combination of LTE Band 20 and NR Band n28	
		R4-1711361				TP for TR 37.863-01-01: DC_1A_n28	
		R4-1711362				TP for TR 37.863-01-01: DC_3A_n28	
		R4-1711364				TP for TR 37.863-01-01: DC_7A_n28	
		R4-1711837				TP for TR 37.863-01-01 MSD for 2DL/2UL DC combinations including Band n77, n78 and n79	
2018-01	RAN4AH-1801	R4-1801110				TR 37.863-01-01_V0.4.0_Rel15_DC band combo of LTE 1DL1UL + one NR band	0.4.0
		R4-1712160				TP on TR 37.863-01-01 for DC_8A-n77A	
		R4-1712162				TP on TR 37.863-01-01 for DC_8A-n257A	
		R4-1712214				TP for TR 37.863-01-01 DC_7A-n257A	
		R4-1712285				TP for TR 37.863-01-01 DC_41A-n41A	
		R4-1712286				TP for TR 37.863-01-01 DC_25A-n41A	
		R4-1712287				TP for TR 37.863-01-01 DC_26A-n41A	

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		R4-1712422				DC_66A_n257A	
		R4-1712461				TP to TR 37.863-01-01:DC_71b_n71b	
		R4-1712512				TP for TR 37.863-01-01 UE requirement for DC_3A_n7A	
		R4-1712606				TP on TR 37.863-01-01 for DC_39A-n78A_BCS0	
		R4-1712607				TP on TR 37.863-01-01 for DC_41A-n78A_BCS0	
		R4-1712608				TP on TR 37.863-01-01 for DC_39A-n79A_BCS0	
		R4-1712609				TP on TR 37.863-01-01 for DC_41A-n79A_BCS0	
		R4-1712610				TP on TR 37.863-01-01 for DC_39A-n258A_BCS0	
		R4-1712611				TP on TR 37.863-01-01 for DC_41A-n258A_BCS0	
		R4-1712741				DC_3A_n258A	
		R4-1712742				DC_7A_n258A	
		R4-1712743				DC_28A_n258A	
		R4-1712761				TP for TR 37.863-01-01: delt Tib and Rib, MSD for DC_8A-n79A	
		R4-1712764				TP for TR 37.863-01-01: ?TIB and ?RIB, MSD for DC_8A-n258A	
		R4-1712821				TP for TR 37.863-01-01 No MSD for DC including Band n257	
		R4-1712894				TP for TR 37.863-01-01 self-interference analysis for DC_1A_n77A	
		R4-1712895				TP for TR 37.863-01-01 self-interference analysis for DC_1A_n78A	
		R4-1712896				TP for TR 37.863-01-01 self-interference analysis for DC_3A_n77A	
		R4-1712897				TP for TR 37.863-01-01 self-interference analysis for DC_3A_n78A	
		R4-1712898				TP for TR 37.863-01-01 self-interference analysis for DC_11A_n79A	
		R4-1712899				TP for TR 37.863-01-01 self-interference analysis for DC_18A_n78A	
		R4-1712900				TP for TR 37.863-01-01 self-interference analysis for DC_18A_n79A	
		R4-1712901				TP for TR 37.863-01-01 self-interference analysis for DC_19A_n78A	
		R4-1712902				TP for TR 37.863-01-01 self-interference analysis for DC_19A_n79A	
		R4-1712903				TP for TR 37.863-01-01 self-interference analysis for DC_21A_n79A	
		R4-1712904				TP for TR 37.863-01-01 self-interference analysis for DC_26A_n78A	
		R4-1712905				TP for TR 37.863-01-01 self-interference analysis for DC_26A_n79A	
		R4-1712906				TP for TR 37.863-01-01 self-interference analysis for DC_28A_n77A	
		R4-1712907				TP for TR 37.863-01-01 self-interference analysis for DC_28A_n78A	
		R4-1712908				TP for TR 37.863-01-01 self-interference analysis for DC_28A_n79A	
		R4-1712909				TP for TR 37.863-01-01 self-interference analysis for DC_39A_n78A	
		R4-1712910				TP for TR 37.863-01-01 self-interference analysis for DC_8A_n78A	
		R4-1712918				TP for TR 37.863-01-01 self-interference analysis for DC_8A_n79A	
		R4-1712920				TP for TR 37.863-01-01 self-interference analysis for DC_20A_n78A	
		R4-1712921				TP for TR 37.863-01-01 self-interference analysis for DC_41A_n79A	
		R4-1712926				TP for TR 37.863-01-01 self-interference analysis for DC_1A_n28A	
		R4-1712927				TP for TR 37.863-01-01 self-interference analysis for DC_3A_n7A	
		R4-1712928				TP for TR 37.863-01-01 self-interference analysis for DC_5A_n78A	
		R4-1712929				TP for TR 37.863-01-01 corrections on interference mixing coefficients	
		R4-1713259				TP on protection bands, MSD level and additional ILs for DC_7A-n78A	
		R4-1713546				TP for TR 37.863-01-01: DC_1A_n28	
		R4-1713548				TP for TR 37.863-01-01: DC_3A_n28	
		R4-1713550				TP for TR 37.863-01-01: DC_7A_n28	
		R4-1713972				TP for TR 37.863-01-01 for DC combinations of LTE bands 11, 18, 26, 41 and NR bands n77, n78, n79, n257	
		R4-1714006				TP for TR 37.863-01-01 DC including LTE Band 42	
		R4-1714007				TP for TR 37.863-01-01 MSD for DC including Band n77, n78 and n79	
		R4-1714008				TP for TR 37.863-01-01 UE-to-UE co-existence for DC including Band n77, n78, n79 and n257	
		R4-1714025				TP for TR37.863-01-01:MSD requirements for DC_8A-n78A	
		R4-1714045				TP on protected bands, additional ILs and MSD level for TR 37.863-01-01 DC_5A_n78A	
		R4-1714046				TP for TR 37863-01-01 UE requirements study for DC_20A-n78A	
		R4-1714086				TP on protected bands, additional ILs and MSD level for TR 37.863-01-01 DC_5A_n257A	
		R4-1714164				TP for TR 37.863-01-01: DC band combination of LTE Band 20 and NR Band n28	
		R4-1714173				TP for TR 37.863-01-01 Harmonic mixing MSD for DC_28-n77 and DC_19-n79	
		R4-1714339				TP for TR 37.863-01-01: Requirements on B3_n78, B3_n77 and B1_n77	
		R4-1714349				DC_66A_n71A	
		R4-1714333				TP on TR 37.863-01-01 for Single Tx Switched UL	
2018-02	RAN4#86	R4-1803462				Updated TR 37.863-01-01 V0.5.0 Rel-15 DC band combination of LTE 1DL/1UL + one NR band	0.5.0
		R4-1800061				TP for TR 37.863-01-01: DC_(n)71B	
		R4-1800294				TP for TR 37.863-01-01 self-interference analysis for DC_26A_n41A	
		R4-1800295				TP for TR 37.863-01-01 self-interference analysis for DC_66A_n71A	
		R4-1800408				TP for TR 37.863-01-01: DC_20A-n8A	

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		R4-1800428				TP on TR 37.863-01-01 for DC_8A-n77A: MSD and missing parts	
		R4-1800430				TP on TR 37.863-01-01 for DC_8A-n257A: addition of band protection requirements	
		R4-1800455				TP for TR 37.863-01-01: Harmonic mixing MSD for DC_26A-n79A	
		R4-1800456				TP for 37.863-01-01: Harmonic MSD for DC_18A-n77A, DC_26A-n77A and DC_26A-n78A	
		R4-1800457				TP for 37.863-01-01: IMD MSD for DC_26A-n77A and DC_26A-n78A	
		R4-1800501				TP for TR 37.863-01-01 DC_46A_n78A	
		R4-1800517				TP for TR 37.863-01-01 for DC combinations of LTE bands 18, 26, 41 and NR bands n77, n78, n79, n257	
		R4-1800818				TP for TR 37.863-01-01 for DC_1A-n50A	
		R4-1800819				TP for TR 37.863-01-01 for DC_1A-n51A	
		R4-1800820				TP for TR 37.863-01-01 for DC_3A-n50A	
		R4-1800821				TP for TR 37.863-01-01 for DC_3A-n51A	
		R4-1800822				TP for TR 37.863-01-01 for DC_7A-n50A	
		R4-1800823				TP for TR 37.863-01-01 for DC_7A-n51A	
		R4-1800824				TP for TR 37.863-01-01 for DC_20A-n50A	
		R4-1800825				TP for TR 37.863-01-01 for DC_20A-n51A	
		R4-1800828				TP for TR 37.863-01-01 for DC_42A-n50A	
		R4-1800829				TP for TR 37.863-01-01 for DC_42A-n51A	
		R4-1800925				TP for TR 37.863-01-01 DC_25A_n41A	
		R4-1800926				TP for TR 37.863-01-01 DC_26A_n41A	
		R4-1800927				TP for TR 37.863-01-01 DC_41A_n41A	
		R4-1800972				TP for TR 37.863-01-01 DC_25A_n41A delta Rib, Tib	
		R4-1800973				TP for TR 37.863-01-01 DC_26A_n41A delta Rib, Tib	
		R4-1801093				TP for TR37.863-01-01:UE to UE coexistence for the combinations of band 8 and n78,n79	
		R4-1801130				TP for TR 37.863-01-01: DC_2A-n71A	
		R4-1801185				TP for TR 37.863-01-01 for DC_28A-n50A	
		R4-1801186				TP for TR 37.863-01-01 for DC_28A-n51A	
		R4-1801188				TP on TR 37.863-01-01 for Single Tx Switched UL	
		R4-1801127				DC_66A_n257A	
		R4-1801128				DC_66A_n71A	
		R4-1800722				DC_3A_n258A	
		R4-1800723				DC_7A_n258A	
		R4-1800724				DC_28A_n258A	
		R4-1801126				DC_66A-n260A TP for TR 37 863-01-01	
		R4-1801151				TP for TR 37.863 DC_2A-n257A	
		R4-1801155				TP for TR 37.863 DC_13A-n257A	
		R4-1801157				TP for TR 37.863 DC_48A-n257A	
		R4-1801170				TP for TR 37.863 DC_5A-n260A	
		R4-1801171				TP for TR 37.863 DC_13A-n260A	
		R4-1801174				TP for TR 37.863 DC_48A-n260A	
		R4-1801481				TP for TR37.863-01-01:Protected bands for the combinations of band 8 and n258	
		R4-1801876				TP to 37.863-01-01 to correct channel BW for DC_66A_n257A	
		R4-1801993				TP on TR 37.863-01-01 for DC_41A-n77A: MSD and protection requirement	
		R4-1802028				TP for TR 37.863-01-01 for DC combinations of LTE bands 11, 18, 26, 41 and NR bands n77, n78, n79, n257	
		R4-1802170				TP for TR 37.863-01-01: DC_3A_n28	
		R4-1802171				TP for TR 37.863-01-01: DC_7A_n28	
		R4-1802199				TP for TR 37.863-01-01: DC_25A_n41 MSD	
		R4-1801644				TP for 37.863-01-01: general co-existence study	
		R4-1802227				TP to TR 37.836-01-01 MSD DC Combination B41+n79	
		R4-1802264				TP for TR 37.863-01-01: Introduction of DC_(n)41C	
		R4-1803185				TP to TR 37.863-01-01: MSD for DC_66A_n71A	
		R4-1803268				TP for TR 37.863-01-01: DC_1A_n28	
		R4-1803269				TP for TR 37.863-01-01: DC_41A_n41 SEM	
2018-03	RAN#79	RP-180150				Presented to RAN plenary for information	1.0.0
2018-04	RAN4#86bis	R4-1804371				Updated TR 37.863-01-01 V1.1.0 Rel-15 DC band combination of LTE 1DL/1UL + one NR band	1.1.0
		R4-1803696				TP for 37.863-01-01: DC_39A-n79A	
		R4-1803697				TP for 37.863-01-01: DC_39A-n258A	
		R4-1803700				TP for 37.863-01-01: DC_41A-n258A	
		R4-1803745				TP on TR 37.863-01-01 for DC_8A-n77A: UL configuration for MSD for H4	
		R4-1803755				TP for TR37.863-01-01 UL configuration for DC combinations Band 8 and n78,n79	
		R4-1804324				TP for TR 37.863-01-01 on MSD for DC_26A_n41A	
		R4-1804940				TP to TR 37.863-01-01: DC_66_n257 (CA_n257 Fallback group 3	

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						BCS0)	
		R4-1805127				TP for TR 37.863-01-01: DC_38A_n78A	
		R4-1805222				TP for TR 37.863-01-01 for DC_7A-n50A	
		R4-1805223				TP for TR 37.863-01-01 for DC_7A-n51A	
		R4-1805224				TP for TR 37.863-01-01 for DC_20A-n50A	
		R4-1805225				TP for TR 37.863-01-01 for DC_20A-n51A	
		R4-1805450				TP for TR 37.863-01-01 correction on DC_66A_n71A	
		R4-1805451				TP for TR 37.863-01-01 self-interference analysis for DC_20A_n8A	
		R4-1805453				TP for TR 37.863-01-01 self-interference analysis for DC_2A_n71A	
		R4-1805454				TP for TR 37.863-01-01 self-interference analysis for DC_28A_n50A	
		R4-1805456				TP for TR 37.863-01-01 self-interference analysis for DC_28A_n51A	
		R4-1805630				TP for 37.863-01-01: DC_39A-n78A	
		R4-1805631				TP for 37.863-01-01: DC_41A-n78A	
		R4-1805632				TP for 37.863-01-01: DC_41A-n79A	
		R4-1805633				TP for TR37.863-01-01 for EN-DC CA_2A-n71A MSD and uplink configuration	
		R4-1805687				TP for TR 37.863-01-01 for DC_1A-n50A	
		R4-1805688				TP for TR 37.863-01-01 for DC_1A-n51A	
		R4-1805689				TP for TR 37.863-01-01 for DC_3A-n50A	
		R4-1805690				TP for TR 37.863-01-01 for DC_3A-n51A	
		R4-1805691				TP for TR 37.863-01-01 for DC_28A-n50A	
		R4-1805692				TP for TR 37.863-01-01 for DC_28A-n51A	
		R4-1805693				TP for TR 37.863-01-01 for DC_42A-n50A	
		R4-1805694				TP for TR 37.863-01-01 for DC_42A-n51A	
		R4-1805732				TP for TR 37.863-01-01 DC_(n)41C DC_41A_n41A SEM	
		R4-1805762				TP for TR 37.863-01-01 DC_5A-n260B, DC_5A-n260C, DC_5A-n260D, DC_5A-n260E, DC_5A-n260F, DC_5A-n260G, DC_5A-n260H, DC_5A-n260I, DC_5A-n260J, DC_5A-n260K, DC_5A-n260L, DC_5A-n260M, DC_5A-n260O, DC_5A-n260P DC_5A-n260Q	
		R4-1805763				TP for TR 37.863-02-01 DC_5A-n261B, DC_5A-n261C, DC_5A-n261D, DC_5A-n261E, DC_5A-n261F, DC_5A-n261G, DC_5A-n261H, DC_5A-n261I, DC_5A-n261J, DC_5A-n261K, DC_5A-n261L, DC_5A-n261M, DC_5A-n261O, DC_5A-n261P, DC_5A-n261Q	
		R4-1805764				TP for TR 37.863-01-01 DC_66A-n260B, DC_66A-n260C, DC_66A-n260D, DC_66A-n260E, DC_66A-n260F, DC_66A-n260G, DC_66A-n260H, DC_66A-n260I, DC_66A-n260J, DC_66A-n260K, DC_66A-n260L, DC_66A-n260M, DC_66A-n260O, DC_66A-n260P DC_66A-n260Q	
		R4-1805765				TP for TR 37.863-02-01 DC_66A-n261B, DC_66A-n261C, DC_66A-n261D, DC_66A-n261E, DC_66A-n261F, DC_66A-n261G, DC_66A-n261H, DC_66A-n261I, DC_66A-n261J, DC_66A-n261K, DC_66A-n261L, DC_66A-n261M, DC_66A-n261O, DC_66A-n261P, DC_66A-n261Q	
2018-05	RAN4#87	R4-1806517				Updated TR 37.863-01-01 V1.2.0 Rel-15 DC band combination of LTE 1DL/1UL + one NR band	1.2.0
		R4-1806214				TP for TR 37.863-01-01 Introduction of DC_2A_n257(2A)	
		R4-1806215				TP for TR 37.863-01-01 Introduction of DC_66A_n257(2A)	
		R4-1806253				TP to TR 37.863-01-01: Removal of square brackets around the 40 MHz channel bandwidth option, for the following EN-DC configurations: DC_1A_n78A, DC_3A_n78A, DC_7A_n78A and DC_20A_n78A	
		R4-1806512				TP for TR 37.863-01-01 to add n77C, n78C, n79C and n257DEF for EN-DC including B1, 3, 19, 21, 28 and 42	
		R4-1806576				TP to TR 37.863-01-01: Introduction of new NR band n7 channel bandwidth options, for DC_3A_n7A	
		R4-1806619				TP for TR 37.863-01-01 Inter-band DC_5A-n260 Carrier Aggregation	
		R4-1806622				TP for TR 37.863-01-01 Inter-band DC_66A-n260 Carrier Aggregation	
		R4-1806623				TP for TR 37.863-01-01 Inter-band DC 5A-n261 Carrier Aggregation	
		R4-1806629				TP for TR 37.863-01-01 Inter-band DC_66A-n261 CA	
		R4-1806769				TP on TR 37.863-01-01 for DC_41A-n77A and 41A-n78A: Corrections	
		R4-1806824				TP for TR 37.863-01-01 MSD for DC_1A_n78A	
		R4-1806825				TP for TR 37.863-01-01 MSD for DC_3A_n78A	
		R4-1806826				TP for TR 37.863-01-01 Remove the duplicate sections for DC_5A_n78A in the TR	
		R4-1806832				TP for TR 37.863-01-01: LTE band 3 plus NR band n3 EN-DC non-contiguous combination	
		R4-1806981				TP for 37.863-01-01:DC_(n)71B	
		R4-1807041				TP to TR 37.863-01-01 MSD for DC_26A_n41A due to IMD3	
		R4-1807109				TP 37.863-01-01 DC_2A_n260A, DC_2A_n260(2A)	

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		R4-1807110				TP 37.863-01-01 DC_66A_n260(2A), DC_66A_n260(3A), DC_66A_n260(4A)	
		R4-1807111				TP 37.863-01-01 DC_12A_n260A	
		R4-1807112				TP 37.863-01-01 DC_30A_n260A	
		R4-1807113				TP 37.863-01-01 DC_2A_n66A	
		R4-1807114				TP 37.863-01-01 DC_5A_n66A	
		R4-1807115				TP 37.863-01-01 DC_12A_n66A	
		R4-1807116				TP 37.863-01-01 DC_30A_n66A	
		R4-1807117				TP 37.863-01-01 DC_2A_n5A	
		R4-1807118				TP 37.863-01-01 DC_12A_n5A	
		R4-1807119				TP 37.863-01-01 DC_30A_n5A	
		R4-1807120				TP 37.863-01-01 DC_66A_n5A	
		R4-1807121				TP 37.863-01-01 DC_1A_n40A	
		R4-1807122				TP 37.863-01-01 DC_3A_n40A	
		R4-1807123				TP 37.863-01-01 DC_5A_n40A	
		R4-1807124				TP 37.863-01-01 DC_8A_n40A	
		R4-1807242				TP for TR 37.863-01-01: DC_66A_n78A	
		R4-1807243				TP for TR 37.863-01-01: DC_2A_n78A	
		R4-1807249				TP for TR 37.863-01-01: DC_20A_n258A	
		R4-1807533				TP for TR 37.863-01-01: DC_40A_n77A	
		R4-1807534				TP for TR 37.863-01-01: DC_20A_n77A	
		R4-1807690				TP for TR 37.863-01-01 for DC_1A-n50A	
		R4-1807691				TP for TR 37.863-01-01 for DC_1A-n51A	
		R4-1807692				TP for TR 37.863-01-01 for DC_3A-n50A	
		R4-1807693				TP for TR 37.863-01-01 for DC_3A-n51A	
		R4-1807694				TP for TR 37.863-01-01 for DC_7A-n50A	
		R4-1807695				TP for TR 37.863-01-01 for DC_7A-n51A	
		R4-1807696				TP for TR 37.863-01-01 for DC_20A-n50A	
		R4-1807697				TP for TR 37.863-01-01 for DC_20A-n51A	
		R4-1807698				:TP for TR 37.863-01-01 for DC_28A-n50A	
		R4-1807699				TP for TR 37.863-01-01 for DC_28A-n51A	
		R4-1807700				TP for TR 37.863-01-01 for DC_42A-n50A	
		R4-1807701				TP for TR 37.863-01-01 for DC_42A-n51A	
		R4-1807819				TP for TR 37.863-01-01 add BCS for DC_(n)41AA and DC_41A_n41A	
		R4-1808056				TP for TR 37.863-01-01: MSD for DC_20A-n8A	
		R4-1806698				UE-UE co-existence for DC_41A-n258A	
		R4-1806843				UL configuration for EN-DC CA_2A-n71A with B71 Rx 3rd order harmonic mixing	
2018-06	RAN#80	RP-180691				V2.0.0 submitted for plenary approval	2.0.0
2018-06	RAN#80					Approved by plenary – Rel-15 spec under change control	15.0.0
2018-09	RAN#81	RP-181896	0001	1	F	Extendng loewer frequecy range in Band 41 for EN DC_41_79	15.1.0
2018-09	RAN#81	RP-181896	0002		F	Correction for DC_3_n3 to Rel.15 TR 37.863-01-01	15.1.0
2018-12	RAN#82	RP-182359	0003	1	F	CR to 37.863-01-01:Corrections on TR for IMD calculations and add TP for MSD for DC_5A_n78A	15.2.0
2018-12	RAN#82	RP-182359	0004		F	CR on MSD for EN-DC including Band 66 and n78 to TR 37.863-01-01	15.2.0
2018-12	RAN#82	RP-182359	0006		F	CR towards TR 37.863-01-01 to correct n260 BW classes	15.2.0
2019-06	RAN#84	RP-191237	0007		F	CR to reflect agreed MSD analysis of DC_25A-n41A for TR37.863-01-01	15.3.0
2020-06	RAN#88	RP-200984	0008	1	F	CR for TR37.863-01-01: TP for missing MSD due to UL harmonic and cross band isolation for band combinations	15.4.0

Petitioners' Exhibit 1037
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