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Technical Report

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Adding wider channel bandwidths in NR band n28;
(Release 16)**

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Contents

Foreword

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

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1 Scope

The present document is a technical report for adding wider channel bandwidths in NR band n28.

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]   RP-192261: " Addition of wider channel bandwidth in NR band n28".

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

[4]   TR36.820: "LTE for 700 MHz digital dividend".

[5]   R4-1913618, "BS-BS co-existence analysis for the new wider channel bandwidth band n28".

[6]   3GPP TS 38.104: "NR; Base Station (BS) radio transmission and reception".

[7]   R4-1914501, "[n28BW] initial MPR simulations results for UL 30MHz channel bandwidth in band n28"

[8]   R4-1913132, "n28 30MHz AMPR"

[9]   R4-2001089, "Updated AMPR 30MHz simulation results for NS_18 in band n28"

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

3.2 Symbols

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

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

4 Background

4.1 Justification

In Release 15, 20 MHz is the supported maximum channel bandwidth for NR band n28, but it significantly restricts the deployment options for operators who have spectrum larger than 20MHz in NR band n28. In order to allow operators to make more efficient use of their available spectrum, it is proposed to add wider channel bandwidth for both BS and UE into NR band n28.

4.2 Objective

The objective of this WI is to add to NR band n28 the support of wider channel bandwidths, with subcarrier spacing of 15kHz and 30kHz. Specifically, it includes the following aspects:

Introduce 30MHz and 40MHz BS channel bandwidth.

Introduce 30MHz UE channel bandwidth.

Note: Used only to lowermost and uppermost channels in band n28.

Specify UE RF requirements if necessary, including the consideration of MPR/A-MPR and RENSENS to address the potential impact on RF requirements.

Investigate whether it is possible and, if possible, enable UE support of 30MHz channel bandwidth in Rel-15 in a release independent manner [RAN2].

5 Study of UE and BS requirements

5.1 UE requirements

5.1.1 UE channel bandwidth

Legacy RF Front-End architecture for band 28 UEs is based on dual duplexer approach, with B28A duplexer covering the range from 703 to 733 MHz, and B28B duplexer covering the range from 718 to 748 MHz. Since each duplexer bandwidth is 30MHz, only two carrier frequencies can be supported when cell is configured for 30MHz CBW operation: 718 MHz for "28A" low duplexer, and 733 MHz for "28B" high duplexer. These restrictions are captured in footnote 7 in Table 5.1.1-1. The channel bandwidths in Table 5.1.1-1 are specified for both the TX and RX path.

Table 5.1.1-1 Channel bandwidths for band n28

NR band / SCS / UE Channel bandwidth													
NR Band	SCS 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	90[4] MHz	100 MHz
n28	15	Yes	Yes	Yes	Yes[7]		Yes[7]						
	30		Yes	Yes	Yes[7]		Yes[7]						
	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.
NOTE 4: This UE channel bandwidth is optional in this release of the specification.
NOTE 5: For this bandwidth, the minimum requirements are restricted to operation when carrier is configured as an SCell part of DC or CA configuration.
NOTE 6: For this bandwidth, the minimum requirements are restricted to operation when carrier is configured as an downlink SCell part of CA configuration.
NOTE 7: For the 20 MHz bandwidth, the minimum requirements are specified for NR UL carrier frequencies confined to either 713-723 MHz or 728-738 MHz.For the 30MHz bandwidth, the minimum requirements are specified for NR UL transmission bandwidth configuration confined to either 703-733 or 718-748 MHz.

5.1.2 Tx requirements

5.1.2.1 MPR requirements

The relative channel bandwidth of n28 30MHz is around 4.1%. It's larger than the 3% criteria of FDD bands. So it's necessary to specify the MPR requirements for n28 30MHz. Referring to MPR simulation results [7], we can find that the MPR requirements in the current spec can be met for UL 30MHz channel bandwidth in band n28. But considering different implementations, the delta MPR need to be considered as margin. The proposed delta MPR (dB) are listed in Table 5.1.2.1-1.

Table 5.1.2.1-1: The proposed delta MPR (dB)

Company	Huawei
The proposed delta MPR (dB)	1

For band n28 30MHz, the allowed maximum power reduction (MPR) is defined in Table 5.1.2.1-2.

Table 5.1.2.1-2: The proposed delta MPR (dB)

UL channel bandwidth Conditions	Power class	The allowed maximum power reduction (MPR)
Band n28 30MHz	Power class 3	Table 6.2.2-1 from 38.101-1 + [1] dB

5.1.2.2 AMPR requirements

There are two network signalling labels for n28 in current spec. For 30MHz channel bandwidth, as announced by Japanese operators, it is concluded that NS_17 extension is not needed at this stage because allocation of such wider CBWs won't be foreseen in the near future in Japan.

In China, the TV system has own standard based on 8MHz bandwidth instead of NS_18/NS_17's 6MHz MBW. Furthermore, additional spectrum emission requirements for 700MHz haven't been specified in China. So NS_17 and NS_18 aren't applicable to China.

It's possible for n28 30MHz deployment in EU.

Referring to the paper [8], Frequency range of UL transmission bandwidth configuration placed at 703~733MHz will require AMPR. The updated AMPR simulation results are captured in the paper [9]. Based on the updated AMPR simulation results, we propose the NS_18 AMPR requirements as below.

Table 5.1.2.2-1 A-MPR regions for NS_18

Channel Bandwidth, MHz	Frequency range of UL transmission bandwidth configuration, MHz	Regions		A-MPR
		$RB_{start}*12*SCS$ MHz	$L_{CRB}*12*SCS$ MHz	
30	703~733	$> (L_{CRB}*12*SCS)/2+ 5.22$	$\geq Max(0, 12*SCS*N_{RB} - 1.8 - RB_{start}*12*SCS)$	A3
		$\leq(L_{CRB}*12*SCS)/2 +5.22$	≥5.4	A4
		≤7.92	<5.4	A5

Table 5.1.2.2-2 A-MPR for NS_18

Modulation/Waveform		A3 Outer/Inner	A4 Outer/Inner	A5 Outer/Inner
DFT-s-OFDM	PI/2 BPSK	[3]	[8]	[3]
	QPSK	[3]	[8]	[3]
	16 QAM	[3]	[8]	[3]
	64 QAM	[3]	[8]	[4.5]
	256 QAM	[3]	[8]	[5.5]
CP-OFDM	QPSK	[4.5]	[9.5]	[5]
	16 QAM	[4.5]	[9.5]	[5]
	64 QAM	[4.5]	[9.5]	[5.5]
	256QAM	[4.5]	[9.5]	[7.5]
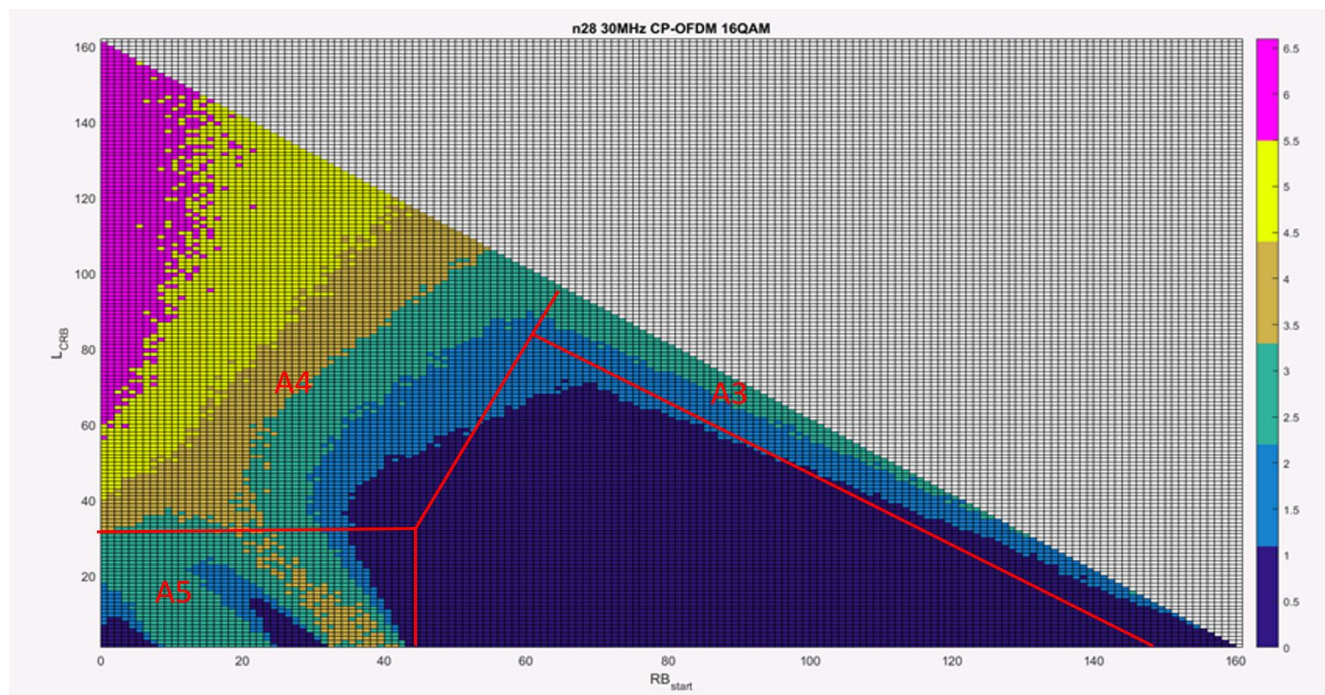
Figure 5.1.2.2-1 NS_18 AMPR regions

5.1.2.3 MPR/AMPR assumption

The MPR/AMPR simulation assumptions for 30MHz in band n28 are listed below.

PA calibrated to deliver -30dBc ACLR for a fully allocated QPSK DFT-S-OFDM waveform at 1 dB MPR,

-28 dBc image and carrier rejection,

30 MHz channel bandwidth located at the lowermost channel (703~733) (Center frequency is 718 MHz.)

CIM3: 60 dBc

5.1.2.4 Spurious emissions for UE co-existence

Mutual co-existence requirements need to be considered between Band 28 and some other bands/band combinations to be used in China, e.g. Band n1, n3, n5, n8, n34, n39, n40, n41, n78 and the combination between these bands. And the current principle of adding protected bands to the protected band list is if the E-UTRA band x has been in the list of protected bands, there is no need to list nx again since the frequency range will be the same between band x and nx. Based on this principle, the following part will give the required changes for introducing band n28 into TS 38.101-1/-3 respectively.

Required changes for TS 38.101-1

Table 5.1.2.4-1: Requirements for spurious emissions for UE co-existence

NR Band	Spurious emission for UE co-existence					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
......						
n1, n84	E-UTRA 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, NR Band n78, n79	F_{DL_low}	-	FDL_high	-50	1	

NR Band	Spurious emission for UE co-existence						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
......							
	NR Band n77	F_{DL_low}	-	F_{DL_high}	-50	1	2
	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
n3, n80	E-UTRA Band 1, 5, 7, 8, 20, 26, 27, 28, 31, 32, 33, 34, 38, 39, 40, 41, 43, 44, 45, 50, 51, 65, 67, 68, 69, 72, 73,74, 75, 76. NR Band n79	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 3	F_{DL_low}	-	F_{DL_high}	-50	1	15
	E-UTRA Band 11, 18, 19, 21	F_{DL_low}	-	F_{DL_high}	-50	1	13
	E-UTRA Band 22, 42, 52, NR Band n77, n78	F_{DL_low}	-	F_{DL_high}	-50	1	2

	......							
n3, n80	Frequency range	1884.5	-	1915.7	-41	0.3	13
n5, n89	E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 10, 12, 13, 14, 17, 18, 19, 24, 25, 26, 28, 29, 30, 31, 34, 38, 40, 42, 43, 45, 48, 50, 51, 53, 65, 66, 70, 71, 73, 74, 85	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 41, 52	F_{DL_low}	-	F_{DL_high}	-50	1	2
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	39
	Frequency range	1884.5	-	1915.7	-41	0.3	8,39
n8, n81	E-UTRA 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	
	E-UTRA band 3, 7, 22, 41, 42, 43, 52, NR Band n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1	2
	E-UTRA 8	F_{DL_low}	-	F_{DL_high}	-50	1	15
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	8
n28, n83	E-UTRA Band 1, 4, 10, 22, 32, 42, 43, 50, 51, 52, 65, 66, 73, 74, 75, 76, NR Band n77, n78	F_{DL_low}	-	F_{DL_high}	-50	1	2
	E-UTRA Band 1	F_{DL_low}	-	F_{DL_high}	-50	1	19, 25
	E-UTRA Band 2, 3, 5, 7, 8, 18, 19, 20, 25, 26, 27, 31, 34, 38, 39, 40, 41, 66, 72, NR Band n79	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	19, 24
	Frequency range	470	-	694	-42	8	15, 35
	Frequency range	470	-	710	-26.2	6	34
	Frequency range	662	-	694	-26.2	6	15
	Frequency range	758	-	773	-32	1	15
	Frequency range	773	-	803	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	8, 19
n34	E-UTRA Band 1, 3, 7, 8, 11, 18, 19, 20, 21, 22, 26, 28, 31, 32, 33, 38,39, 40, 41, 42, 43, 44, 45, 50, 51, 52, 65, 67, 69, 72, 74,	F_{DL_low}	-	F_{DL_high}	-50	1	5

	75, 76, NR Band n78, n79						
	NR Band n77	F_{DL_low}	-	F_{DL_high}	-50	1	2
	Frequency range	1884.5	-	1915.7	-41	0.3	8
n39	E-UTRA Band 1, 8, 22, 26, 28, 34, 40, 41, 42, 44, 45, 50, 51, 52, 74, NR Band n79	F_{DL_low}	-	F_{DL_high}	-50	1	
	NR Band n77, n78	F_{DL_low}	-	F_{DL_high}	-50	1	2
	Frequency range	1805	-	1855	-40	1	33
	Frequency range	1855	-	1880	-15.5	5	15, 26, 33
n40	E-UTRA Band 1, 3, 5, 7, 8, 20, 22, 26, 27, 28, 31, 32, 33, 34, 38, 39, 42, 43, 44, 45, 50, 51, 52, 65, 67, 68, 69, 72, 74, 75, 76, NR Band n77, n78	F_{DL_low}	-	F_{DL_high}	-50	1	
	NR Band n79	F_{DL_low}	-	F_{DL_high}	-50	1	2
n41	E-UTRA Band 1, 2, 3, 4, 5, 8, 10, 12, 13, 14, 17, 24, 25, 26, 27, 28, 29, 30, 34, 39, 42, 44, 45, 48, 50, 51, 52, 65, 66, 70, 71, 73, 74, 85, NR Band n77, n78	F_{DL_low}	-	F_{DL_high}	-50	1	
	NR Band n79	F_{DL_low}	-	F_{DL_high}	-50	1	2
	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

Table 5.1.2.4-2: Requirements for uplink inter-band carrier aggregation (two bands)

NR CA combination	Spurious emission						
	Protected Band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
CA_n1-n8	E-UTRA Band 20, 28, 31, 32, 38, 40, 45, 50, 51, 65, 67, 68, 69, 72, 73, 74, 75, 76	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 3, 7, 22, 41, 42, 43 NR Band n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1	2
	E-UTRA Band 1, 8, 34	F_{DL_low}	-	F_{DL_high}	-50	1	4
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	5
	Frequency range	1884.5	-	1915.7	-41	0.3	3
	Frequency range	1880	-	1895	-40	1	4, 6
	Frequency range	1895	-	1915	-15.5	5	4, 6, 7
	Frequency range	1915	-	1920	+1.6	5	4, 6, 7
CA_n1-n28	E-UTRA Band 5, 7, 8, 18, 19, 20, 26, 27, 31, 32, 38, 40, 41, 50, 51, 72, 74	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 42, 43, 75, 76 NR band n78	F_{DL_low}	-	F_{DL_high}	-50	1	2
	E-UTRA Band 3, 34	F_{DL_low}	-	F_{DL_high}	-50	1	4
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	11, 15
	E-UTRA Band 1, 65	F_{DL_low}	-	F_{DL_high}	-50	1	11, 12
	Frequency range	470	-	694	-42	8	4, 14
	Frequency range	470	-	710	-26.2	6	15
	Frequency range	758	-	773	-30	1	4
	Frequency range	773	-	803	-50	1	
	Frequency range	662	-	694	-26.2	6	4
	Frequency range	1880	-	1895	-40	1	4, 6
	Frequency range	1895	-	1915	-15.5	5	4, 6, 7
	Frequency range	1915	-	1920	+1.6	5	4, 6, 7
	Frequency range	1839.9	-	1879.9	-50	1	4
	Frequency range	1884.5	-	1915.7	-41	0.3	11, 17
CA_n1-n78	E-UTRA Band 1, 3, 5, 7, 8, 11, 18, 19, 20, 21, 26, 28, 34, 40, 41, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	1880	-	1895	-40	1	4, 6
	Frequency range	1895	-	1915	-15.5	5	4, 6, 7
	Frequency range	1915	-	1920	+1.6	5	4, 6, 7
CA_n1-n79	E-UTRA Band 1, 3, 5, 7, 8, 11, 18, 19, 21, 26, 28, 34, 40, 41, 42, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	1880	-	1895	-40	1	4, 6
	Frequency range	1895	-	1915	-15.5	5	4, 6, 7
	Frequency range	1915	-	1920	+1.6	5	4, 6, 7
CA_n2-n48	E-UTRA Band 4, 5, 12, 13, 14, 17, 24, 25, 26, 29, 30, 41, 50, 51, 53, 66, 70, 71, 74, 85	F_{DL_low}	-	F_{DL_high}	-50	1	
CA_n3-n8	E-UTRA Band 1, 20, 28, 31, 32, 33, 34, 38, 39, 40, 44, 50, 51, 65, 67, 72, 73, 74, 75, 76	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA band 3, 8	F_{DL_low}	-	F_{DL_high}	-50	1	2, 4
	E-UTRA band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	5
	E-UTRA band 7, 22, 41, 42, 43, 52 NR Band n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1	2
	Frequency range	1884.5	-	1915.7	-41	0.3	3
	Frequency range	860	-	890	-40	1	4, 5
CA_n3-n28	E-UTRA Band 5, 7, 8, 18, 19, 20, 26, 27, 31, 32, 38, 40, 41, 50, 51, 72, 74	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 42, 43, 75, 76 NR band n78	F_{DL_low}	-	F_{DL_high}	-50	1	2

	E-UTRA Band 3, 34	F_{DL_low}	-	F_{DL_high}	-50	1	4
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	11, 15
	E-UTRA Band 1, 65	F_{DL_low}	-	F_{DL_high}	-50	1	11, 12
	Frequency range	470	-	694	-42	8	4, 14
	Frequency range	470	-	710	-26.2	6	15
	Frequency range	758	-	773	-30	1	4
	Frequency range	773	-	803	-50	1	
	Frequency range	662	-	694	-26.2	6	4
	Frequency range	1880	-	1895	-40	1	4, 6
	Frequency range	1895	-	1915	-15.5	5	4, 6, 7
	Frequency range	1915	-	1920	+1.6	5	4, 6, 7
	Frequency range	1839.9	-	1879.9	-50	1	4
	Frequency range	1884.5	-	1915.7	-41	0.3	11, 17
CA_n3-n41	E-UTRA Band 1, 5, 8, 20, 26, 27, 28, 34, 39, 40, 44, 45, 50, 51, 65, 73, 74	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 3	F_{DL_low}	-	F_{DL_high}	-50	1	4
	E-UTRA Band 11, 18, 19, 21	F_{DL_low}	-	F_{DL_high}	-50	1	9, 10
	E-UTRA Band 42, NR Band n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1	2
	Frequency range	1884.5	-	1915.7	-41	0.3	3
CA_n3-n78	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	3
CA_n3-n79	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	2
	Frequency range	1884.5	-	1915.7	-41	0.3	3
CA_n5-n78	E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 10, 12, 13, 14, 17, 24, 25, 28, 29, 30, 31, 34, 38, 40, 42, 43, 45, 48, 65, 66, 70	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 26	859	-	869	-27	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	3
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	
	E-UTRA Band 41	F_{DL_low}	-	F_{DL_high}	-50	1	7
CA_n5-n79	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, 73, 74, 85	F_{DL_low}	-	F_{DL_high}			
	E-UTRA Band 26	859	-	869	-27	1	
	E-UTRA Band 41, 52	F_{DL_low}	-	F_{DL_high}	-50	1	2
	Frequency range	1884.5	-	1915.7	-41	0.3	3
CA_n7-n28	E-UTRA Band 2, 3, 5, 7, 8, 20, 26, 27, 31, 34, 40 72	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 1, 4, 10, 42, 43, 50, 51, 65, 66, 74, 75, 76 NR band n78	F_{DL_low}	-	F_{DL_high}	-50	1	2
	E-UTRA Band n1	F_{DL_low}	-	F_{DL_high}	-50	1	11, 12
	Frequency range	758	-	773	-32	1	4
	Frequency range	773	-	803	-50	1	
	Frequency range	2570	-	2575	+1.6	5	4, 7, 18
	Frequency range	2575	-	2595	-15.5	5	4, 7, 18
	Frequency range	2595	-	2620	-40	1	4, 18
CA_n7-n66	E-UTRA Band 2, 4, 5, 7, 10, 12, 13, 14, 17, 26, 27, 28, 29, 30, 43, 66, 71, , 85	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 42	F_{DL_low}	-	F_{DL_high}	-50	1	2
	Frequency range	2570	-	2575	+1.6	5	4, 7, 18
	Frequency range	2575	-	2595	-15.5	5	4, 7, 18
	Frequency range	2595	-	2620	-40	1	4, 18

CA_n7-n78	E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 10, 11, 18, 19, 20, 21, 26, 27, 28, 31, 32, 33, 34, 40, 50, 51, 65, 66, 67, 68, 72, 74, 75, 76	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	2570	-	2575	+1.6	5	4, 7, 18
	Frequency range	2575	-	2595	-15.5	5	4, 7, 18
	Frequency range	2595	-	2620	-40	1	4, 18
CA_n8-n39	E-UTRA Band 1, 28, 34, 40, 50, 51, 74	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 22, 41, 42 NR Band n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1	2
	E-UTRA 8	F_{DL_low}	-	F_{DL_high}	-50	1	4
CA_n8-n41	E-UTRA Band 1, 28, 34, 39, 40, 45, 50, 51, 65, 73,74, NR band n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA band 3, 42, 52	F_{DL_low}	-	F_{DL_high}	-50	1	2
	E-UTRA band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	5
	Frequency range	1884.5	-	1915.7	-41	0.3	3
CA_n8-n78	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	2
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	5
	Frequency range	860	-	890	-40	1	4,5
	Frequency range	1884.5	-	1915.7	-41	0.3	3
CA_n8-n79	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	2
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	5
	Frequency range	860	-	890	-40	1	4, 5
	Frequency range	1884.5	-	1915.7	-41	0.3	3
CA_n20-n28	E-UTRA Band 1, 3, 7, 22, 28, 31, 32, 34, 38, 42, 43, 65, 75, 76 NR Band n78	F_{DL_low}	-	F_{DL_high}	-50	1	
CA_n25-n41	E-UTRA Band 4, 5, 10, 12, 13 , 14, 17, 24, 26, 27, 28, 29, 30, 42, 45, 48, 66, 70, 71	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 2, 25	F_{DL_low}	-	F_{DL_high}	-50	1	4
CA_n28-n50	E-UTRA Band 2, 3, 5, 7, 8, 18, 19, 25, 26, 27, 29, 31, 34, 38, 39, 40, 41, 48, 52, 67, 72, 85 NR Band n79	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 4, 10, 12, 13, 17, 22, 42, 43, 52, 65, 66, 73 NR Band n77, n78	F_{DL_low}	-	F_{DL_high}	-50	1	2
	E-UTRA Band 1	F_{DL_low}	-	F_{DL_high}	-50	1	10, 11
	Frequency range	470	-	694	-42	8	4, 14
	Frequency range	470	-	710	-26.2	6	13
	Frequency range	662	-	694	-26.2	6	4
	Frequency range	758	-	773	-32	1	4
	Frequency range	773	-	803	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	3, 11
CA_n28-n77	E-UTRA Band 3, 5, 7, 8, 18, 19, 20, 26, 34, 39, 40, 41	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 1	F_{DL_low}	-	F_{DL_high}	-50	1	11
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	11
	Frequency range	758	-	773	-32	1	
	Frequency range	773	-	803	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	3, 11
CA_n28-n78	E-UTRA Band 3, 5, 7, 8, 18, 19, 20, 26, 34, 39, 40, 41	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	E-UTRA Band 1	F_{DL_low}	-	F_{DL_high}	-50	1	11
	E-UTRA Band 11, 21	F_{DL_low}	-	F_{DL_high}	-50	1	11

	Frequency range	758	-	773	-32	1	
	Frequency range	773	-	803	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	3, 11
CA_n39-n41	E-UTRA Band 1, 8, 26, 28, 34, 40, 42, 44, 45, 50, 51, 74	F_{DL_low}	-	F_{DL_high}	-50	1	
	NR Band n77, n78, n79	F_{DL_low}	-	F_{DL_high}	-50	1	2
	Frequency range	1805	-	1855	-40	1	4
	Frequency range	1855	-	1880	-15.5	5	4, 7, 8
CA_n39-n79	E-UTRA Band 1, 8, 28, 34, 40, 41, 44, 45 NR Band n78	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	1805	-	1855	-40	1	4, 8
	Frequency range	1855	-	1880	-15.5	5	4, 7, 8
CA_n40-n41	E-UTRA Band 1, 3, 5, 8, 26, 27, 28, 34, 39, 42, 44, 45, 50, 51, 65, 73, 74, NR Band n77, n78	F_{DL_low}	-	F_{DL_high}	-50	1	
	NR Band n79	F_{DL_low}	-	F_{DL_high}	-50	1	2
	Frequency range	1884.5	-	1915.7	-41	0.3	3, 10
CA_n40-n79	E-UTRA Band 1, 3, 5, 8, 28, 34, 39, 41, 42, 65,	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	3, 10
CA_n41-n50	E-UTRA Band 1, 2, 3, 4, 5, 8, 10, 12, 13 , 14, 17, 20, 24, 25, 26, 27, 28, 29, 30, 31, 34, 38, 39, 40, 42, 43, 44, 45, 48, 52, 65, 66, 67, 68, 70, 71, 73, 85 NR Band n77, n78	F_{DL_low}	-	F_{DL_high}	-50	1	
	NR Band n79	F_{DL_low}	-	F_{DL_high}	-50	1	2
CA_n41-n79	E-UTRA Band 1, 3, 5, 8, 9, 11, 18, 19, 21, 28, 34, 40, 42, 44, 45, 65	F_{DL_low}	-	F_{DL_high}	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	3
CA_n48-n66	E-UTRA Band 2, 4, 5, 7, 10, 12, 13, 14, 17, 24, 25, 26, 27, 29, 30, 41, 50, 51, 66, 70, 71, 74, 85	F_{DL_low}	-	F_{DL_high}	-50	1	
CA_n50-n78	E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 10, 12, 13, 17, 20, 25, 26, 27, 28, 29, 31, 33, 34, 38, 39, 40, 41, 44, 48, 65, 66, 67, 68, 69, 72, 73, 85 NR Band n79	F_{DL_low}	-	F_{DL_high}	-50	1	

NOTE 1: F_{DL_low} and F_{DL_high} refer to each frequency band specified in Table 5.2-1 in TS 38.101-1 or Table 5.5-1 in TS 36.101

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

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

NOTE 4: These requirements also apply for the frequency ranges that are less than F_{OOB} (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth.

NOTE 5: This requirement is applicable only for the following cases: A: for carriers of 5 MHz channel bandwidth when carrier centre frequency (F_c) is within the range 902.5 MHz ≤ F_c < 907.5 MHz with an uplink transmission bandwidth less than or equal to 20 RB; B: for carriers of 5 MHz channel bandwidth when carrier centre frequency (F_c) is within the range 907.5 MHz ≤ Fc ≤ 912.5 MHz without any restriction on uplink transmission bandwidth; D: for carriers of 10 MHz channel bandwidth when carrier centre frequency (F_c) is F_c = 910 MHz with an uplink transmission bandwidth less than or equal to 32 RB with RB_{start} > 3.

NOTE 6: This requirement is applicable for any channel bandwidths within the range 1920 – 1980 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 1927.5 - 1929.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 1930 – 1938 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB.

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

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	the protected operating band.
NOTE 8:	This requirement is only applicable for carriers with bandwidth confined within 1885-1920 MHz (requirement for carriers with at least 1RB confined within 1880 - 1885 MHz is not specified). This requirement applies for an uplink transmission bandwidth less than or equal to 54 RB for carriers of 15 MHz bandwidth when carrier center frequency is within the range 1892.5 - 1894.5 MHz and for carriers of 20 MHz bandwidth when carrier center frequency is within the range 1895 - 1903 MHz.
NOTE 9:	This requirement applies for 5, 10, 15 and 20 MHz NR channel bandwidth allocated within 1744.9 MHz and 1784.9 MHz.
NOTE 10:	This requirement applies when the NR carrier is confined within 2545 - 2575 MHz or 2595 – 2645vMHz and the channel bandwidth is 10 or 20 MHz.
NOTE 11:	Applicable when the assigned NR carrier is confined within 718 MHz and 748 MHz and when the channel bandwidth used is 5 or 10 MHz.
NOTE 12:	As exceptions, measurements with a level up to the applicable requirement of -36 dBm/MHz is permitted for each assigned NR carrier used in the measurement due to 3rd harmonic spurious emissions. An exception is allowed if there is at least one individual RB within the transmission bandwidth (see Figure 5.3.1-1) for which the 3rd harmonic totally or partially overlaps the measurement bandwidth (MBW).
NOTE 13:	This requirement is applicable for 5 and 10 MHz NR channel bandwidth allocated within 718 - 728 MHz. For carriers of 10 MHz bandwidth, this requirement applies for an uplink transmission bandwidth less than or equal to 30 RB with RBstart > 1 and Rbstart < 48.
NOTE 14:	This requirement is applicable in the case of a 10 MHz NR carrier confined within 703 MHz and 733 MHz, otherwise the requirement of -25 dBm with a measurement bandwidth of 8 MHz applies.
NOTE 15:	As exceptions, measurements with a level up to the applicable requirement of -38 dBm/MHz is permitted for each assigned E-UTRA carrier used in the measurement due to 3rd harmonic spurious emissions. An exception is allowed if there is at least one individual RB within the transmission bandwidth (see Figure 5.6-1) for which the 3rd harmonic totally or partially overlaps the measurement bandwidth (MBW).
NOTE 17:	Applicable when NS_05 in section 6.6.3.3.1 is signalled by the network.
NOTE 18:	This requirement is applicable for any channel bandwidths within the range 2500 – 2570 MHz with the following restriction: for carriers of 15 MHz bandwidth when carrier centre frequency is within the range 2560.5 - 2562.5 MHz and for carriers of 20 MHz bandwidth when carrier centre frequency is within the range 2552 – 2560 MHz the requirement is applicable only for an uplink transmission bandwidth less than or equal to 54 RB.

Required changes for TS 38.101-3

Table 5.1.2.4-3: additional spurious emission requirements for EN-DC

EN-DC Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
DC_1_n3	E-UTRA Band 1, 5, 7, 8, 11, 18, 19, 20, 21, 26, 27, 28, 31, 32, 38, 40, 41, 43, 44, 50, 51, 65, 67, 72, 73, 74, 75, 76	FDL_low	- FDL_high	-50	1	
	E-UTRA band 3, 34	FDL_low	- FDL_high	-50	1	5
	E-UTRA band 22, 42, 52	FDL_low	- FDL_high	-50	1	2
	Frequency range	1884.5	- 1915.7	-41	0.3	16
	Frequency range	1880	1895	-40	1	5,17
	Frequency range	1895	1915	-15.5	5	5, 7, 17
	Frequency range	1915	1920	+1.6	5	5, 7, 17
DC_1_n5	E-UTRA Band 1, 5, 7, 8, 22, 26, 28, 31, 38, 40, 42, 43, 50, 51, 65, 73, 74 NR Band n77, n78, n79	FDL_low	- FDL_high	-50	1	
	E-UTRA band 3,34	FDL_low	- FDL_high	-50	1	5
	E-UTRA band 41, 52	FDL_low	- FDL_high	-50	1	2
DC_1_n8	E-UTRA Band 20, 28, 31, 32, 38, 40, 45, 50, 51, 65, 67, 68, 69, 72, 73, 74, 75, 76	FDL_low	- FDL_high	-50	1	
	E-UTRA band 3, 7, 22, 41, 42, 43, 52 NR Band n77, n78, n79	FDL_low	- FDL_high	-50	1	2
	E-UTRA Band 1, 8, 34	FDL_low	- FDL_high	-50	1	5
	E-UTRA band 11, 21	FDL_low	- FDL_high	-50	1	12
	Frequency range	860	- 890	-40	1	5, 12
	Frequency range	1884.5	- 1915.7	-41	0.3	12, 15
	Frequency range	1880	1895	-40	1	5, 16
	Frequency range	1895	1915	-15.5	5	5, 7, 16
	Frequency range	1915	1920	+1.6	5	5, 7, 16
DC_1_n28	E-UTRA Band 5, 7, 8, 18, 19, 20, 26, 27, 31, 32, 38, 40, 41, 50, 51, 72, 74 NR band n79	FDL_low	- FDL_high	-50	1	
	E-UTRA Band 42, 43, 75, 76 NR band n78	FDL_low	- FDL_high	-50	1	2
	E-UTRA band 3, 34	FDL_low	- FDL_high	-50	1	5
	E-UTRA Band 11, 21	FDL_low	- FDL_high	-50	1	9, 11
	E-UTRA Band 1, 65	FDL_low	- FDL_high	-50	1	9, 10
	Frequency range	470	- 694	-42	8	5, 17
	Frequency range	470	- 710	-26.2	6	14
	Frequency range	758	- 773	-32	1	5
	Frequency range	773	- 803	-50	1	
	Frequency range	662	- 694	-26.2	6	5
	Frequency range	1880	- 1895	-40	1	5,16
	Frequency range	1895	- 1915	-15.5	5	5, 7, 16
	Frequency range	1915	- 1920	+1.6	5	5, 7, 16
	Frequency range	1839.9	- 1879.9	-50	1	5
	Frequency range	1884.5	- 1915.7	-41	0.3	9, 15
DC_1_n40	E-UTRA Band 1, 5, 7, 8, 11, 18, 19, 20, 21, 22, 26, 27, 28, 31, 32, 38, 41, 42, 43, 44, 45, 50, 51, 52, 65, 67, 68, 69, 72, 73,	FDL_low	- FDL_high	-50	1	

EN-DC Configuration	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
	74, 75, 76						
	Band 3, 34	FDL_low	-	FDL_high	-50	1	5
	Frequency range	1880		1895	-40	1	5, 17
	Frequency range	1895		1915	-15.5	5	5, 7, 17
	Frequency range	1915		1920	+1.6	5	5, 7, 17
DC_1_n41	E-UTRA Band 3, 4, 5, 8, 12, 13, 14, 17, 19, 20, 21, 24, 26, 27, 28, 29, 30, 31, 32, 40, 42, 43, 44, 45, 50, 51, 52, 66, 67, 68, 71, 72, 73, 75, 76, 85 NR Band n78	FDL_low	-	FDL_high	-50	1	
	E-UTRA Band 34	FDL_low	-	FDL_high	-50	1	5
	NR Band n77, n79	FDL_low	-	FDL_high	-50	1	2
	Frequency range	1880		1895	-40	1	5, 8
	Frequency range	1895		1915	-15.5	5	5, 7, 8
	Frequency range	1915		1920	+1.6	5	5, 7, 8, 20
	E-UTRA Band 9, 11, 18, 19, 21, 74	FDL_low	-	FDL_high	-50	1	20
	Frequency range	1884.5	-	1915.7	-41	0.3	3, 20
DC_3_n1	E-UTRA Band 1, 5, 7, 8, 11, 18, 19, 20, 21, 26, 27, 28, 31, 32, 38, 40, 41, 43, 44, 50, 51, 65, 67, 72, 73, 74, 75, 76	FDL_low	-	FDL_high	-50	1	
	E-UTRA band 3, 34	FDL_low	-	FDL_high	-50	1	5
	E-UTRA band 22, 42, 52	FDL_low	-	FDL_high	-50	1	2
	Frequency range	1884.5	-	1915.7	-41	0.3	16
	Frequency range	1880		1895	-40	1	5,17
	Frequency range	1895		1915	-15.5	5	5, 7, 17
	Frequency range	1915		1920	+1.6	5	5, 7, 17
DC_3_n5	E-UTRA Band 1, 5, 7, 8, 22, 26, 28, 31, 38, 40, 42, 43, 50, 51, 65, 73, 74	FDL_low	-	FDL_high	-50	1	
	E-UTRA band 3,34	FDL_low	-	FDL_high	-50	1	5
	E-UTRA Band 52	FDL_low	-	FDL_high	-50	1	2
DC_3_n40	E-UTRA Band 1, 5, 7, 8, 20, 26, 27, 28, 31, 32, 33, 34, 38, 39, 41, 43, 44. 45, 50, 51, 65, 67, 68, 69, 72, 73, 75, 76	FDL_low	-	FDL_high	-50	1	
	E-UTRA Band 3	FDL_low	-	FDL_high	-50	1	5
	E-UTRA Band 22, 42, 52	FDL_low	-	FDL_high	-50	1	2
	Frequency range	1884.5	-	1915.7	-41	0.3	3
DC_3-n41	E-UTRA Band 1, 5, 8, 20, 26, 27, 28, 34, 39, 40, 44, 45, 50, 51, 65, 73, 74	FDL_low	-	FDL_high	-50	1	
	E-UTRA Band 3	FDL_low	-	FDL_high	-50	1	5
	E-UTRA Band 11, 18, 19, 21	FDL_low	-	FDL_high	-50	1	14, 20
	E-UTRA Band 42, NR Band n77, n78, n79	FDL_low	-	FDL_high	-50	1	2
	Frequency range	1884.5	-	1915.7	-41	0.3	3, 20
DC_5_n78	E-UTRA Band 1, 2, 3, 4, 5, 7, 8, 10, 12, 13, 14, 17, 24, 25, 28, 29, 30, 31, 34, 38, 40, 45, 48,	FDL_low	-	FDL_high	-50	1	

EN-DC Configuration	Spurious emission					
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
	65, 66, 70						
	E-UTRA Band 26	859	-	869	-27	1	
	Frequency range	945	-	960	-50	1	
	Frequency range	1884.5	-	1915.7	-41	0.3	3, 4
	Frequency range	2545	-	2575	-50	1	
	Frequency range	2595	-	2645	-50	1	
	E-UTRA Band 41	FDL_low	-	FDL_high	-50	1	7
	E-UTRA Band 18, 19	FDL_low	-	FDL_high	-40	1	4
	E-UTRA Band 11, 21	FDL_low	-	FDL_high	-50	1	4
DC_8_n1	E-UTRA Band 20, 28, 31, 32, 38, 40, 50, 51, 65, 67, 72, 73, 74, 75, 76	FDL_low	-	FDL_high	-50	1	
	E-UTRA band 3, 7, 22, 41, 42, 43, 52 NR Band n77, n78, n79	FDL_low	-	FDL_high	-50	1	2
	E-UTRA Band 1, 8, 34	FDL_low	-	FDL_high	-50	1	5
	E-UTRA band 11, 21	FDL_low	-	FDL_high	-50	1	12
	Frequency range	860	-	890	-40	1	5, 12
	Frequency range	1884.5	-	1915.7	-41	0.3	12, 15
	Frequency range	1880		1895	-40	1	5, 16
	Frequency range	1895		1915	-15.5	5	5, 7, 16
	Frequency range	1915		1920	+1.6	5	5, 7, 16
DC_8_n3	E-UTRA Band 1, 20, 28, 31, 32, 33, 34, 38, 39, 40, 44, 50, 51, 65, 67, 72, 73, 74, 75, 76	FDL_low	-	FDL_high	-50	1	
	E-UTRA band 3, 8	FDL_low	-	FDL_high	-50	1	2, 5
	E-UTRA band 11, 21	FDL_low	-	FDL_high	-50	1	12
	E-UTRA band 7, 22, 41, 42, 43, 52 NR Band n77, n78, n79	FDL_low	-	FDL_high	-50	1	2
	Frequency range	1884.5	-	1915.7	-41	0.3	3.12
	Frequency range	860	-	890	-40	1	5. 12
DC_8_n39	E-UTRA Band 1, 28, 34, 40, 45, 50, 51, 73, 74	FDL_low	-	FDL_high	-50	1	
	UTRA Band 22, 41, 42, 52 NR Band n77, n78, n79	FDL_low	-	FDL_high	-50	1	2
	E-UTRA Band 8	FDL_low	-	FDL_high	-50	1	5
DC_8_n40	E-UTRA Band 1, 20, 28, 31, 32, 33, 34, 38, 39,, 45, 50, 51, 65, 67, 68, 69, 72, 73, 74, 75, 76	FDL_low	-	FDL_high	-50	1	
	E-UTRA Band 3, 7, 22, 41, 42, 43, 52	FDL_low	-	FDL_high	-50	1	2
	E-UTRA Band 8	FDL_low	-	FDL_high	-50	1	5
	E-UTRA Band 11, 21	FDL_low	-	FDL_high	-50	1	12
	Frequency range	860	-	890	-40	1	5, 12
	Frequency range	1884.5	-	1915.7	-41	0.3	3 , 12
DC_8_41	E-UTRA Band 1, 28, 34, 39, 40, 45, 50, 51, 65, 73,74, n77,78,79	FDL_low	-	FDL_high	-50	1	
	E-UTRA band 3, 42, 52	FDL_low	-	FDL_high	-50	1	2
	E-UTRA band 11, 21	FDL_low	-	FDL_high	-50	1	

EN-DC Configuration	Spurious emission					
	Protected band	Frequency range (MHz)		Maximum Level (dBm)	MBW (MHz)	NOTE
	Frequency range	1884.5	- 1915.7	-41	0.3	3
	Frequency range	1884.5	- 1915.7	-41	0.3	3
DC_39-n41	E-UTRA Band 1, 8, 26, 28, 34, 40, 42, 44, 45, 50, 51, 74	FDL_low	- FDL_high	-50	1	
	NR Band n77, n78, n79	FDL_low	- FDL_high	-50	1	2
	Frequency range	1805	- 1855	-40	1	5
	Frequency range	1855	- 1880	-15.5	5	5, 7, 19
DC_39_n78	E-UTRA Band 1, 8, 28, 34, 40, 41, 44, 45	FDL_low	- FDL_high	-50	1	
	Frequency range	1805	- 1855	-40	1	18
	Frequency range	1855	- 1880	-15.5	5	18
DC_39_n79	E-UTRA Band 1, 8, 28, 34, 40, 41, 44, 45	FDL_low	- FDL_high	-50	1	
	Frequency range	1805	- 1855	-40	1	18
	Frequency range	1855	- 1880	-15.5	5	18
DC_40_n1	E-UTRA Band 1, 3, 5, 7, 8, 20, 22, 26, 27, 28, 31, 32, 38, 41, 42, 43, 44, 45, 50, 51, 52, 65, 67, 68, 69, 72, 73, 74, 75, 76 NR Band n78	FDL_low	- FDL_high	-50	1	
	E-UTRA Band 34	FDL_low	- FDL_high	-50	1	5
	NR Band n77, n79	FDL_low	- FDL_high	-50	1	2
DC_40_n41	Bands 1, 3, 5, 8, 26, 27, 28, 34, 39, 42, 44, 45, 50, 51, 65, 73, 74, NR Band n77, n78	FDL_low	- FDL_high	-50	1	
	NR Band n79	FDL_low	- FDL_high	-50	1	2
	Frequency range	1884.5	- 1915.7	-41	0.3	3, 19
DC_40_n78	E-UTRA Band 1, 3, 5, 7, 8, 20, 22, 26, 27, 28, 31, 32, 33, 34, 38, 39, 41, 42, 43, 44, 45, 50, 51, 52, 65, 67, 68, 69, 72, 73, 74, 75, 76 NR Band n77, n78	FDL_low	- FDL_high	-50	1	
	NR Band n79	FDL_low	- FDL_high	-50	1	2
DC_40_n79	Bands 1, 3, 5, 8, 28, 34, 39, 41, 42, 65	FDL_low	- FDL_high	-50	1	
	Frequency range	1884.5	- 1915.7	-41	0.3	3, 19
DC_41_n79	E-UTRA Band 1, 3, 5, 8, 9, 11, 18, 19, 21, 28, 34, 40, 42, 44, 45, 65	FDL_low	- FDL_high	-50	1	
	Frequency range	1884.5	- 1915.7	-41	0.3	3

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

5.1.3   Rx requirements

5.1.3.1 REFSENS

In RAN4#92bis, it's agreed to evaluate two cases in band n28 with same UL RB allocation (assumption: 25RB for 15KHz SCS, 10RB for 30KHz SCS).

Case 1: asymmetric channel bandwidth (UL 20MHz/DL 30MHz)

Case 2: symmetric 30 MHz channel bandwidth

The results proposed by companies are shown below.

REFSENS for case 1

company		MTK	Skyworks	QCOM	Average
Operating Band	SCS kHz	30MHz (dBm)	30 MHz (dBm)	30 MHz (dBm)	30 MHz (dBm)
n28	15	-88.2	-88.7	-88.4	-88.4
	30	-88.3	-88.8	-88.6	-88.6
	60				

REFSENS for case 2

company		ZTE	Huawei	MTK	Skyworks	QCOM	Murata	Average	Median
Operating Band	SCS kHz	30MHz (dBM)	30 MHz (dBm)	30MHz (dBm)	30 MHz (dBm)	30 MHz (dBm)	30 MHz (dBm)	30 MHz (dBm)	30 MHz (dBm)
n28	15	-79.4	-79.9	-79.9	-78.5	-77.8	-76.6	-78.7	-78.5
	30	-79.5	-80	-80	-78.6	-78	-76.7	-78.8	-78.6
	60								

It's agreed to use the Median value (Skyworks' results) as the REFSENS requirements.

The reference sensitivities are shown in table 5.1.3.1-1 for 30MHz in band n28. The UL configurations for n28 30MHz are shown in table 5.1.3.1-2.

Table 5.1.3.1-1 reference sensitivity for band n28

Operating band / SCS / Channel bandwidth / Duplex-mode													
Operating 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)	Duplex Mode
n28	15	-98.5	-95.5	-93.5	-90.8		-78.5							FDD
	30		-95.6	-93.6	-91.0		-78.6							
	60													

NOTE 1: Four Rx antenna ports shall be the baseline for this operating band except for two Rx vehicular UE.
NOTE 2: The transmitter shall be set to P_{UMAX} as defined in subclause 6.2.4
NOTE 3: The requirement is modified by -0.5 dB when the assigned NR channel bandwidth is confined within 1475.9 - 1510.9 MHz.
NOTE 4: The requirement is modified by -0.5 dB when the assigned UE channel bandwidth is confined within 3300 - 3800 MHz.
NOTE 5: For these bandwidths, the minimum requirements are restricted to operation when carrier is configured as a downlink carrier part of CA configuration

Table 5.1.3.1-2: n28 Uplink Configuration for Reference Sensitivity

Operating band / SCS / Channel bandwidth / Duplex mode													
Operating Band	SCS kHz	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Duplex Mode
n28	15	25	25[1]	25[1]	25[1]		25[1]							FDD
	30		10[1]	10[1]	10[1]		10[1]							

NOTE 1: UL resource blocks shall be located as close as possible to the downlink operating band but confined within the transmission bandwidth configuration for the channel bandwidth (Table 5.3.2-1).

5.2 BS requirements

5.2.1 Channel bandwidth

30MHz and 40MHz BS channel bandwidth for band n28 will be introduced into TS 38.104[6] as specified in table 5.2.1-1.

Table 5.2.1-1: *BS channel bandwidths* and SCS for band n28

NR band / SCS / *BS channel bandwidth*														
NR Band	SCS kHz	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	70 MHz	80 MHz	90 MHz	100 MHz
n28	15	Yes	Yes	Yes	Yes		Yes	Yes						
	30		Yes	Yes	Yes		Yes	Yes						
	60													

5.2.2 BS-BS co-existence

Figure 5.2.2-1 shows the 3GPP spectrum around band n28. Band 5/V, Band 18, Band 19/XIX, Band 26/XXVI and band 27 are legacy bands, and Band n5 is NR band. thus impact in current performance needs to be specifically addressed.
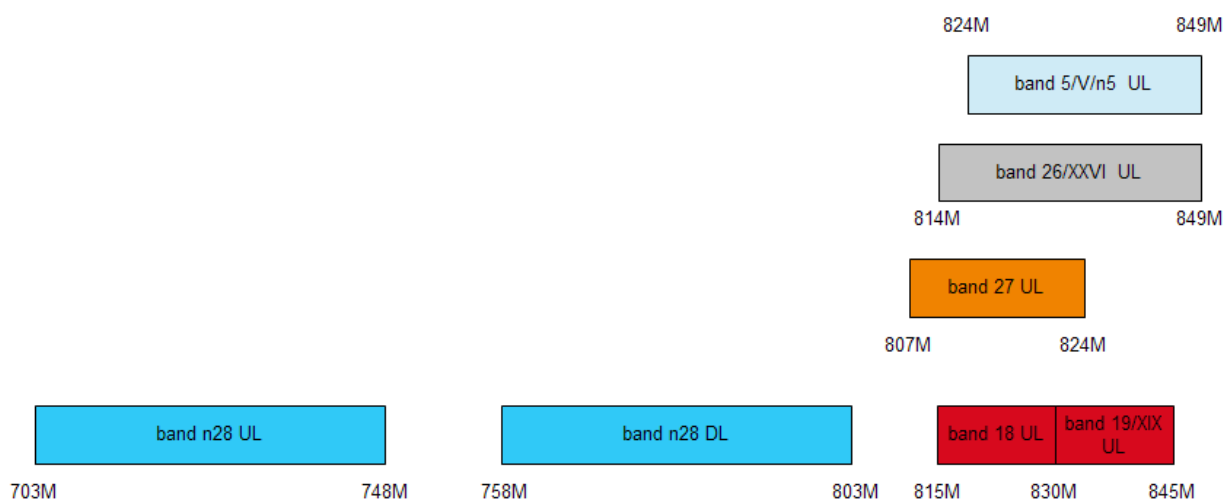

Figure 5.2.2-1. 3GPP spectrum around band n28

Since the LTE band 28 is the refarming band of NR band n28, so the BS-BS co-existence analysis and the consensus in section 7.2 in TR36.820 [4] can be applied to the BS-BS co-existence studies for band n28 co-existence with band 5/X UL, band 26/XXVI UL, band 18 UL and band 19/XIX UL.

In TR36.820, for the co-existence between APT700MHz FDD (i.e. LTE band 28) with some nearby 3GPP bands, the consensus are cited as follow:

BS-BS co-existence between Band 5/V and APT700 is not an issue

BS-BS co-existence between Band 26/XXVI and APT700 is not an issue

BS-BS co-existence between Band 18 and 19/XIX and APT700 is achievable.

It shall be noted the above consensus are applied for the while band, regardless the supported channel bandwidth. The above consensus can be applied for band n28 co-existence with band 5/X/n5 UL, band 26/XXVI UL, band 18 UL and band 19/XIX UL. Hence there are no BS-BS co-existence issues to introduce 30MHz and 40MHz for band n28 co-existence with the above nearby 3GPP bands.Regarding the BS co-existence issues between band n28 and band 27, filter capability is an important factor. The band 27 Rx filter can provide enough attenuation to fulfill ACS and in band-blocking regardless the supported channel bandwidth of band n28. Although the duplexer gap between UL and DL for band n28 is only 10MHz and the frequency gap between the band n28 with band 27 UL is only 4MHz, it is still possible

to implement the RF filter design with full band bandwidth to fulfill the co-existence requirements between band 27 and band n28 but the filter volume could be larger.

In addition, from the analysis in [5], it can be concluded that there exists some other possible solutions to solve the co-existence issues between band 27 and band n28. By using certain specific solutions, sub-band filters (40MHz Tx bandwidth) as an example, band n28 can protect band 27 UL with the standard level of -49dBm/MHz.

Annex A: Change history

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2019-10	RAN4#92bis	R4-1911158				TR 38.888 v0.0.1 Adding wider channel bandwidth in NR band n28	0.0.1
2019-11	RAN4#93					Approved TP lists in RAN4#93 meeting R4-1916061 TP on UE spurious emission requirements for band n28 R4-1914503 [n28BW] TP to add UE Tx requirements for 30MHz channel bandwidth in band n28 R4-1915215 TP for TR 38.888 on Footnote for 30MHz Channel Bandwidth in Band n28 R4-1916064 TP for TR38.888: BS-BS co-existence analysis R4-1916063 [n28BW] TP on BS RF requirements for adding wider channel bandwidth in band n28	
2020-02	RAN4#94-e	R4-2000165				Updated TR 38.888 v0.1.0: Adding wider channel bandwidths in NR band n28. The update is based on the following TPs approved in RAN4#93. R4-1916061 TP on UE spurious emission requirements for band n28 R4-1914503 [n28BW] TP to add UE Tx requirements for 30MHz channel bandwidth in band n28 R4-1915215 TP for TR 38.888 on Footnote for 30MHz Channel Bandwidth in Band n28 R4-1916064 TP for TR38.888: BS-BS co-existence analysis R4-1916063 [n28BW] TP on BS RF requirements for adding wider channel bandwidth in band n28	0.1.0
2020-03	RAN#87-e	RP-200131				Approved TP lists in RAN4#94-e meeting R4-2002847 TP on UE RF REFSENS for adding wider channel bandwidth in band n28 R4-2002846 TP on UE Tx RF requirements for adding wider channel bandwidth in band n28 R4-2001170 Remove band 39 from protected band list of DC_1-n28	1.0.0

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2020-03	RAN#87					Approved by plenary – Rel-16 spec under change control	16.0.0