ETSI TS 138 101-2 V15.2.0 (2018-07)

TECHNICAL SPECIFICATION

5G;
NR;
User Equipment (UE) radio transmission and reception;
Part 2: Range 2 Standalone
(3GPP TS 38.101-2 version 15.2.0 Release 15)

Reference
RTS/TSGR-0438101-2vf20

Keywords
5G

ETSI

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Sous-Préfecture de Grasse (06) N° 7803/88

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Contents

Foreword

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1 Scope

The present document establishes the minimum RF characteristics and minimum performance requirements for NR User Equipment (UE) operating on frequency Range 2.

2 References

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

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

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

[2] 3GPP TS 38.101-1: “NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone”

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

[4] 3GPP TR 38.810: “Study on test methods for New Radio”

[5] 3GPP TS 38.521-2: “NR; User Equipment (UE) conformance specification; Radio transmission and reception; Part 2: Range 2 Standalone"

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

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

[8] 47 CFR Part 30, “UPPER MICROWAVE FLEXIBLE USE SERVICE, §30.202 Power limits”, FCC.

[9] 3GPP TS 38.211: "NR; Physical channels and modulation".

[10] 3GPP TS 38.213: "NR; Physical layer procedures for control".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

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

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

Carrier aggregation band: A set of one or more operating bands across which multiple carriers are aggregated with a specific set of technical requirements.

Carrier aggregation bandwidth class: A class defined by the aggregated transmission bandwidth configuration and maximum number of component carriers supported by a UE.

Carrier aggregation configuration: A combination of CA operating band(s) and CA bandwidth class(es) supported by a UE.

NOTE: Carriers aggregated in each band can be contiguous or non-contiguous.

EIRP(Link=Link angle, Meas=Link angle): measurement of the UE such that the link angle is aligned with the measurement angle. EIRP (indicator to be measured) can be replaced by EIS, Frequency, EVM, carrier Leakage, In-band eission and OBW. Beam peak search grids, TX beam peak direction, and RX beam peak direction can be selected to describe Link.

EIRP(Link=Link angle, Meas=beam peak direction): measurement of the EIRP of the UE such that the measurement angle is aligned with the beam peak direction within an acceptable measurement error uncertainty.

Fallback group: Group of carrier aggregation bandwidth classes for which it is mandatory for a UE to be able to fallback to lower order CA bandwidth class configuration. It is not mandatory for a UE to be able to fallback to lower order CA bandwidth class configuration that belong to a different fallback group

Inter-band carrier aggregation: Carrier aggregation of component carriers in different operating bands.

NOTE: Carriers aggregated in each band can be contiguous or non-contiguous.

Intra-band contiguous carrier aggregation: Contiguous carriers aggregated in the same operating band.

Intra-band non-contiguous carrier aggregation: Non-contiguous carriers aggregated in the same operating band.

Link angle: a DL-signal AoA from the view point of the UE, as described in Table C.2-1 in [4].

Measurement angle: the angle of measurement of the desired metric from the view point of the UE, as described in Table C.2-1 in [4].

radiated interface boundary: operating band specific radiated requirements reference point where the radiated requirements apply

RX beam peak direction: direction where the maximum total component of RSRP and thus best total component of EIS is found

Sub-block: This is one contiguous allocated block of spectrum for transmission and reception by the same UE. There may be multiple instances of sub-blocks within an RF bandwidth.

TX beam peak direction: direction where the maximum total component of EIRP is found

TRP(Link=Link angle): measurement of the TRP of the UE such that the measurement angle is aligned with the beam peak direction within an acceptable measurement uncertainty. TX beam peak direction and RX beam peak direction can be selected to describe Link.

NOTE: For requirements based on EIRP/EIS, the radiated interface boundary is associated to the far-field region

3.2 Symbols

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

ΔF_{Global}	Granularity of the global frequency raster
ΔF_{Raster}	Band dependent channel raster granularity
Δf_{OOB}	Δ Frequency of Out Of Band emission
Δ_{SUL}	Channel raster offset for SUL
F_{OOB}	The boundary between the NR out of band emission and spurious emission domains
$BW_{Channel}$	Channel bandwidth
$BW_{Channel\_CA}$	Aggregated channel bandwidth, expressed in MHz.
F_{REF}	RF reference frequency
L_{CRB}	Transmission bandwidth which represents the length of a contiguous resource block allocation expressed in units of resources blocks
MPR_{narrow}	Maximum output power reduction due to narrow PRB allocation

MPR_{WT} Maximum power reduction due to modulation orders, transmit bandwidth configurations, waveform types
NR_{ACLR} NR ACLR
N_{RB} Transmission bandwidth configuration, expressed in units of resource blocks

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].

ACLR Adjacent Channel Leakage Ratio
ACS Adjacent Channel Selectivity
AoA Angle of Arrival
CA Carrier aggregation
CC Component carrier
FWA Fixed Wireless Access
RIB Radiated Interface Boundary
TRP Total Radiated Power
UE User Equipment

4 General

4.1 Relationship between minimum requirements and test requirements

The present document is a Single-RAT specification for NR UE, covering RF characteristics and minimum performance requirements. Conformance to the present specification is demonstrated by fulfilling the test requirements specified in the conformance specification 3GPP TS 38.521-2 [7].

The Minimum Requirements given in this specification make no allowance for measurement uncertainty. The test specification TS 38.521-2 [5] defines test tolerances. These test tolerances are individually calculated for each test. The test tolerances are used to relax the minimum requirements in this specification to create test requirements. For some requirements, including regulatory requirements, the test tolerance is set to zero.

The measurement results returned by the test system are compared - without any modification - against the test requirements as defined by the shared risk principle.

The shared risk principle is defined in Recommendation ITU R M.1545 [6].

4.2 Applicability of minimum requirements

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

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

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

4.3 Specification suffix information

Unless stated otherwise the following suffixes are used for indicating at 2nd level subclause, shown in Table 4.3-1.

Table 4.3-1: Definition of suffixes

Clause suffix	Variant
None	Single Carrier
A	Carrier Aggregation (CA)
B	Dual-Connectivity (DC)
C	Supplement Uplink (SUL)
D	UL MIMO
NOTE: Suffix D in this specification represents both polarized UL MIMO and spatial UL MIMO. RF requirements are same.	

5 Operating bands and channel arrangement

5.1 General

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

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

Requirements throughout the RF specifications are in many cases defined separately for different frequency ranges (FR). The frequency ranges in which NR can operate according to this version of the specification are identified as described in Table 5.1-1.

Table 5.1-1: Definition of frequency ranges

Frequency range designation	Corresponding frequency range
FR1	450 MHz – 6000 MHz
FR2	24250 MHz – 52600 MHz

The present specification covers FR2 operating bands.

5.2 Operating bands

NR is designed to operate in the FR2 operating bands defined in Table 5.2-1.

Table 5.2-1: NR operating bands in FR2

Operating Band	Uplink (UL) operating band BS receive UE transmit	Downlink (DL) operating band BS transmit UE receive	Duplex Mode
	F_{UL_low} – F_{UL_high}	F_{DL_low} – F_{DL_high}	
n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD
n258	24250 MHz – 27500 MHz	24250 MHz – 27500 MHz	TDD
n260	37000 MHz – 40000 MHz	37000 MHz – 40000 MHz	TDD
n261	27500 MHz – 28350 MHz	27500 MHz – 28350 MHz	TDD

5.2A Operating bands for CA

5.2A.1 Intra-band CA

NR intra-band contiguous carrier aggregation is designed to operate in the operating bands defined in Table 5.2A.1-1, where all operating bands are within FR2.

Table 5.2A.1-1: Intra-band contiguous CA operating bands in FR2

NR CA Band	NR Band (Table 5.2-1)
CA_n257B	n257
CA_n257D	n257
CA_n257E	n257
CA_n257F	n257
CA_n257G	n257
CA_n257H	n257
CA_n257I	n257
CA_n257J	n257
CA_n257K	n257
CA_n257L	n257
CA_n257M	n257
CA_n260B	n260
CA_n260C	n260
CA_n260D	n260
CA_n260E	n260
CA_n260F	n260
CA_n260G	n260
CA_n260H	n260
CA_n260I	n260
CA_n260J	n260
CA_n260K	n260
CA_n260L	n260
CA_n260M	n260
CA_n260O	n260
CA_n260P	n260
CA_n260Q	n260
CA_n261B	n261
CA_n261C	n261
CA_n261D	n261
CA_n261E	n261
CA_n261F	n261
CA_n261G	n261
CA_n261H	n261
CA_n261I	n261
CA_n261J	n261
CA_n261K	n261
CA_n261L	n261
CA_n261M	n261
CA_n261O	n261
CA_n261P	n261
CA_n261Q	n261

5.2A.2 Inter-band CA

NR inter-band carrier aggregation is designed to operate in the operating bands defined in Table 5.2A.2-1, where all operating bands are within FR2.

Table 5.2A.2-1: Inter-band CA operating bands involving FR2 (two bands)

NR CA Band	NR Band (Table 5.2-1)
CA_nX-nY	nX, nY

Editor’s note: The above tables should only cover band combinations where the NR bands are in FR2. More tables may be added based on the agreed CA band combinations.

5.2D Operating bands for UL-MIMO

NR UL-MIMO is designed to operate in the operating bands defined in Table 5.2D-1.

Table 5.2D-1: NR UL-MIMO operating bands

UL-MIMO operating band (Table 5.2-1)
n257

5.3 UE Channel bandwidth

5.3.1 General

The UE channel bandwidth supports a single NR RF carrier in the uplink or downlink at the UE. From a BS perspective, different UE channel bandwidths may be supported within the same spectrum for transmitting to and receiving from UEs connected to the BS. Transmission of multiple carriers to the same UE (CA) or multiple carriers to different UEs within the BS channel bandwidth can be supported.

From a UE perspective, the UE is configured with one or more BWP / carriers, each with its own UE channel bandwidth. The UE does not need to be aware of the BS channel bandwidth or how the BS allocates bandwidth to different UEs.

The placement of the UE channel bandwidth for each UE carrier is flexible but can only be completely within the BS channel bandwidth.

5.3.2 Maximum transmission bandwidth configuration

The maximum transmission bandwidth configuration N_{RB} for each UE channel bandwidth and subcarrier spacing is specified in Table 5.3.2-1

Table 5.3.2-1: Maximum transmission bandwidth configuration N_{RB}

SCS (kHz)	50MHz	100MHz	200MHz	400 MHz
	N_{RB}	N_{RB}	N_{RB}	N_{RB}
60	66	132	264	N.A
120	32	66	132	264

5.3.3 Minimum guardband and transmission bandwidth configuration

The minimum guardband for each UE channel bandwidth and SCS is specified in Table 5.3.3-1 The relationship between the channel bandwidth, the guardband and the transmission bandwidth configuration is shown in Figure 5.3.3-1.

Table 5.3.3-1: Minimum guardband for each UE channel bandwidth and SCS (kHz)

SCS (kHz)	50MHz	100MHz	200MHz	400 MHz
60	1210	2450	4930	N. A
120	1900	2420	4900	9860

NOTE: The minimum guardbands have been calculated using the following equation: (CHBW x 1000 (kHz) - RB value x SCS x 12) / 2 - SCS/2, where RB values are from Table 5.3.2-1.

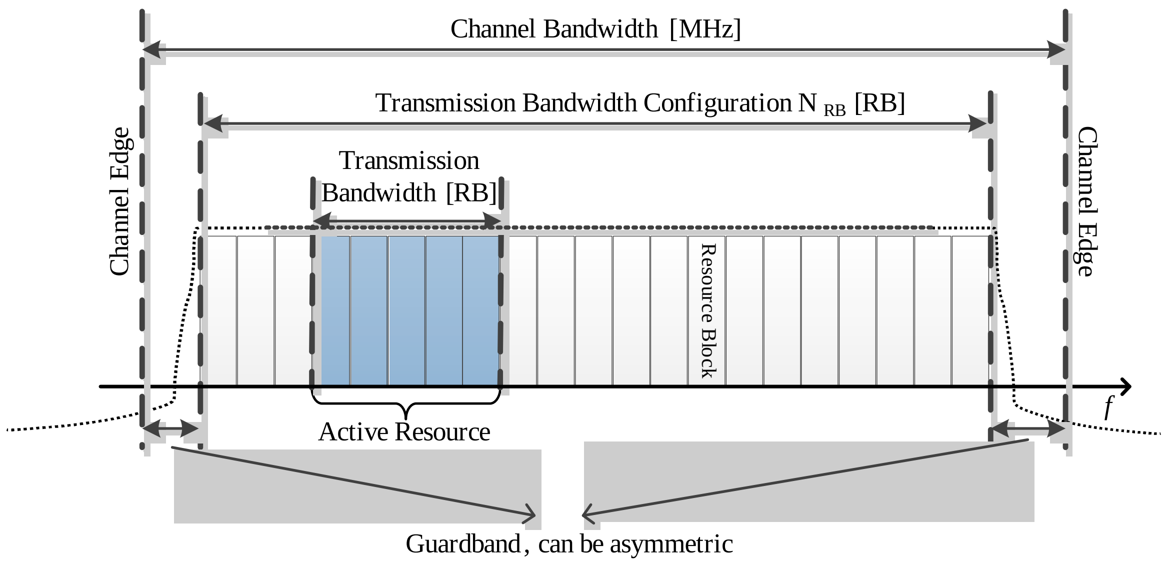

Figure 5.3.3-1: Definition of channel bandwidth and transmission bandwidth configuration for one NR channel

The number of RBs configured in any channel bandwidth shall ensure that the minimum guardband specified in this clause is met.

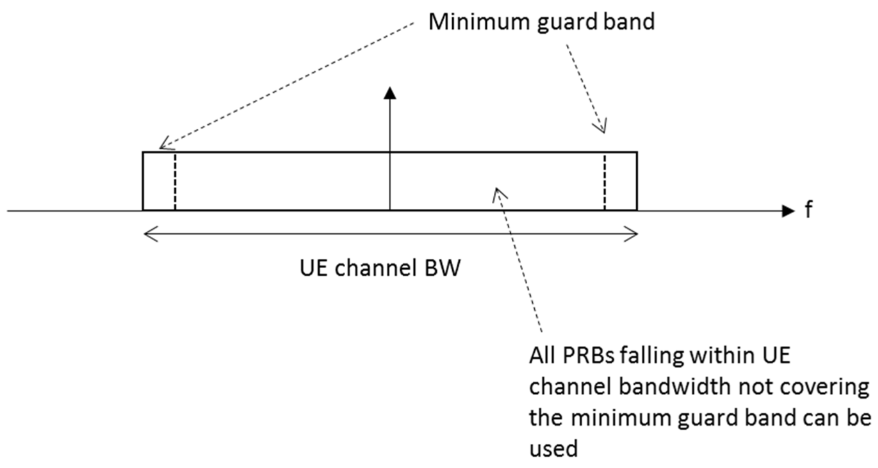

Figure 5.3.3-2 UE PRB utilization

In the case that multiple numerologies are multiplexed in the same symbol due to BS transmission of SSB, the minimum guardband on each side of the carrier is the guardband applied at the configured channel bandwidth for the numerology that is transmitted immediately adjacent to the guard band.

If multiple numerologies are multiplexed in the same symbol and the UE channel bandwidth is > 200 MHz, the minimum guardband applied adjacent to 60 kHz SCS shall be the same as the minimum guardband defined for 120 kHz SCS for the same UE channel bandwidth.

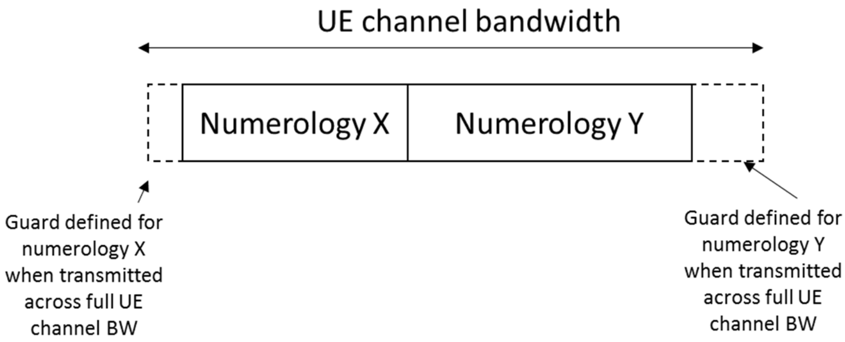

Figure 5.3.3-3 Guard band definition when transmitting multiple numerologies

Note: Figure 5.3.3-3 is not intended to imply the size of any guard between the two numerologies. Inter-numerology guard band within the carrier is implementation dependent.

The minimum guardband of receiving BS SCS 240 kHz SS/PBCH block for each UE channel bandwidth is specified in table 5.3.3-2 for FR2.

Table: 5.3.3-2: Minimum guardband (kHz) of SCS 240 kHz SS/PBCH block

SCS (kHz)	100 MHz	200 MHz	400 MHz
240	3800	7720	15560

Note: The minimum guardband in Table 5.3.3-2 is applicable only when the SCS 240 kHz SS/PBCH block is received adjacent to the edge of the UE channel bandwidth within which the SS/PBCH block is located.

5.3.4 RB alignment with different numerologies

For each numerology, its common resource blocks are specified in Section 4.4.4.3 in [9], and the starting point of its transmission bandwidth configuration on the common resource block grid for a given channel bandwidth is indicated by an offset to "Reference point A" in the unit of the numerology. The indicated transmission bandwidth configuration must fulfil the minimum guardband requirement specified in Section 5.3.3.

5.3.5 Channel bandwidth per operating band

The requirements in this specification apply to the combination of channel bandwidths, SCS and operating bands shown in Table 5.3.5-1. The transmission bandwidth configuration in Table 5.3.2-1 shall be supported for each of the specified channel bandwidths. The channel bandwidths are specified for both the Tx and Rx path.

Table 5.3.5-1: Channel bandwidths for each NR band

Operating band / SCS / UE channel bandwidth					
Operating band	SCS kHz	50 MHz	100 MHz	200 MHz	400 MHz
n257	60	Yes	Yes	Yes	
	120	Yes	Yes	Yes	Yes
n258	60	Yes	Yes	Yes	
	120	Yes	Yes	Yes	Yes
n260	60	Yes	Yes	Yes	
	120	Yes	Yes	Yes	Yes
n261	60	Yes	Yes	Yes	
	120	Yes	Yes	Yes	Yes

5.3A UE channel bandwidth

5.3A.1 General

5.3A.2 Minimum guardband and transmission bandwidth configuration for CA

5.3A.3 RB alignment with different numerologies for CA

5.3A.4 UE channel bandwidth per operating band for CA

For intra-band contiguous carrier aggregation, a carrier aggregation configuration is a single operating band supporting a carrier aggregation bandwidth class with associated bandwidth combination sets specified in clause 5.5A.1. For each carrier aggregation configuration, requirements are specified for all aggregated channel bandwidths contained in a bandwidth combination set, UE can indicate support of several bandwidth combination sets per carrier aggregation configuration.

For intra-band non-contiguous carrier aggregation, a carrier aggregation configuration is a single operating band supporting two or more sub-blocks, each supporting a carrier aggregation bandwidth class.

For inter-band carrier aggregation, a carrier aggregation configuration is a combination of operating bands, each supporting a carrier aggregation bandwidth class.

Table 5.3A.4-1: CA bandwidth classes

NR CA bandwidth class	Aggregated channel bandwidth	Number of contiguous CC	Fallback group
A	$BW_{Channel} \leq 400$ MHz	1	
B	400 MHz < $BW_{Channel\_CA} \leq 800$ MHz	2	1
C	800 MHz < $BW_{Channel\_CA} \leq 1200$ MHz	3	
D	200 MHz < $BW_{Channel\_CA} \leq 400$ MHz	2	2
E	400 MHz < $BW_{Channel\_CA} \leq 600$ MHz	3	
F	600 MHz < $BW_{Channel\_CA} \leq 800$ MHz	4	
G	100 MHz < $BW_{Channel\_CA} \leq 200$ MHz	2	3
H	200 MHz < $BW_{Channel\_CA} \leq 300$ MHz	3	
I	300 MHz < $BW_{Channel\_CA} \leq 400$ MHz	4	
J	400 MHz < $BW_{Channel\_CA} \leq 500$ MHz	5	
K	500 MHz < $BW_{Channel\_CA} \leq 600$ MHz	6	
L	600 MHz < $BW_{Channel\_CA} \leq 700$ MHz	7	
M	700 MHz < $BW_{Channel\_CA} \leq 800$ MHz	8	
O	100 MHz $\leq BW_{Channel\_CA} \leq 200$ MHz	2	4
P	150 MHz $\leq BW_{Channel\_CA} \leq 300$ MHz	3	
Q	200 MHz $\leq BW_{Channel\_CA} \leq 400$ MHz	4	
NOTE 1: Maximum supported component carrier bandwidths for fallback groups 1, 2, 3 and 4 are 400 MHz, 200 MHz, 100 MHz and 100 MHz respectively. NOTE 2: It is mandatory for a UE to be able to fallback to lower order CA bandwidth class configuration within a fallback group. It is not mandatory for a UE to be able to fallback to lower order CA bandwidth class configuration that belong to a different fallback group.			

5.3D Channel bandwidth for UL-MIMO

The requirements specified in subclause 5.3 are applicable to UE supporting UL-MIMO.

5.4 Channel arrangement

5.4.1 Channel spacing

5.4.1.1 Channel spacing for adjacent NR carriers

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

For NR operating bands with 60 kHz channel raster,

$$\text{Nominal Channel spacing} = (BW_{Channel(1)} + BW_{Channel(2)})/2 + \{-20\text{kHz}, 0\text{kHz}, 20\text{kHz}\}$$

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

5.4.2 Channel raster

5.4.2.1 NR-ARFCN and channel raster

The global frequency raster defines a set of RF reference frequencies F_{REF}. The RF reference frequency is used in signalling to identify the position of RF channels, SS blocks and other elements.

The global frequency raster is defined for all frequencies from 0 to 100 GHz. The granularity of the global frequency raster is ΔF_{Global}.

RF reference frequency is designated by an NR Absolute Radio Frequency Channel Number (NR-ARFCN) in the range [2016667...3279165] on the global frequency raster. The relation between the NR-ARFCN and the RF reference frequency F_{REF} in MHz is given by the following equation, where $F_{REF-Offs}$ and $N_{Ref-Offs}$ are given in table 5.4.2.1-1 and N_{REF} is the NR-ARFCN

$$F_{REF} = F_{REF-Offs} + \Delta F_{Global} (N_{REF} - N_{REF-Offs})$$

Table 5.4.2.1-1: NR-ARFCN parameters for the global frequency raster

Frequency range (MHz)	ΔF_{Global} (kHz)	$F_{REF-Offs}$ [MHz]	$N_{REF-Offs}$	Range of N_{REF}
24250 – 100000	60	24250.08	2016667	2016667 – 3279165

The *channel raster* defines a subset of *RF reference frequencies* that can be used to identify the RF channel position in the uplink and downlink. The *RF reference frequency* for an RF channel maps to a resource element on the carrier. For each operating band, a subset of frequencies from the global frequency raster are applicable for that band and forms a channel raster with a granularity ΔF_{Raster}, which may be equal to or larger than ΔF_{Global}.

NOTE: The position of an RF channel can be identified through other reference points than the channel raster, such as “point A” defined in TR 38.211 [9].

The mapping between the channel raster and corresponding resource element is given in Section 5.4.2.2. The applicable entries for each operating band are defined in subclause 5.4.2.3

5.4.2.2 Channel raster to resource element mapping

The mapping between the RF reference frequency on channel raster and the corresponding resource element is given in Table 5.4.2.2-1 and can be used to identify the RF channel position. The mapping depends on the total number of RBs that are allocated in the channel and applies to both UL and DL. The mapping must apply to at least one numerology supported by the UE.

Table 5.4.2.2-1: Channel raster to resource element mapping

	$N_{\text{RB}} \bmod 2 = 0$	$N_{\text{RB}} \bmod 2 = 1$
Resource element index k	0	6
Physical resource block number n_{PRB}	$n_{\text{PRB}} = \left\lfloor \frac{N_{\text{RB}}}{2} \right\rfloor$	$n_{\text{PRB}} = \left\lfloor \frac{N_{\text{RB}}}{2} \right\rfloor$

k, n_{PRB}, N_{RB} are as defined in TS 38.211 [9].

5.4.2.3 Channel raster entries for each operating band

The RF channel positions on the channel raster in each NR operating band are given through the applicable NR-ARFCN in Table 5.4.2.3-1, using the channel raster to resource element mapping in subclause 5.4.2.2.

- For NR operating bands with 60 kHz channel raster above 24 GHz, $\Delta F_{\text{Raster}} = \Delta F_{\text{Global}}$. In this case all NR-ARFCN within the operating band are applicable for the channel raster within the operating band and the step size for the channel raster in Table 5.4.2.3-1 is given as <1>.

- In frequency bands with two ΔF_{Raster}, the higher ΔF_{Raster} applies to channels using only the SCS that equals the higher ΔF_{Raster}.

Table 5.4.2.3-1: Applicable NR-ARFCN per operating band

Operating Band	ΔFRaster (kHz)	Uplink and Downlink Range of NREF (First – <Step size> – Last)
n257	60	2054166 – <1> – 2104165
	120	2054167 – <2> – 2104165
n258	60	2016667 – <1> – 2070832
	120	2016667 – <2> – 2070831
n260	60	2229166 – <1> – 2279165
	120	2229167 – <2> – 2279165
n261	60	2070833 – <1> – 2084999
	120	2070833 – <2> – 2087497

5.4.3 Synchronization raster

5.4.3.1 Synchronization raster and numbering

The synchronization raster indicates the frequency positions of the synchronization block that can be used by the UE for system acquisition when explicit signalling of the synchronization block position is not present.

A global synchronization raster is defined for all frequencies. The frequency position of the SS block is defined as SS_{REF} with corresponding number GSCN. The parameters defining the SS_{REF} and GSCN for all the frequency ranges are in Table 5.4.3.1-1.

The resource element corresponding to the SS block reference frequency SS_{REF} is given in subclause 5.4.3.2. The synchronization raster and the subcarrier spacing of the synchronization block is defined separately for each band.

Table 5.4.3.1-1: GSCN parameters for the global frequency raster

Frequency range	SS block frequency position SS_{REF}	GSCN	Range of GSCN
24250 – 100000 MHz	24250.08 MHz + N * 17.28 MHz, N = 0:4383	22256 + N	[22256 – 26639]

5.4.3.2 Synchronization raster to synchronization block resource element mapping

The mapping between the synchronization raster and the corresponding resource element of the SS block is given in Table 5.4.3.2-1. The mapping depends on the total number of RBs that are allocated in the channel and applies to both UL and DL.

Table 5.4.3.2-1: Synchronization raster to SS block resource element mapping

Resource element index k	0
Physical resource block number n_{PRB} of the SS block	$n_{PRB} = 10$

k, n_{PRB}, are as defined in TS 38.211 [9].

5.4.3.3 Synchronization raster entries for each operating band

The synchronization raster for each band is give in Table 5.4.3.3-1. The distance between applicable GSCN entries is given by the <Step size> indicated in Table 5.4.3.3-1.

Table 5.4.3.3-1: Applicable SS raster entries per operating band

NR Operating Band	SS Block SCS	SS Block pattern[1]	Range of GSCN (First – <Step size> – Last)
n257	120 kHz	Case D	22388 - <1> - 22558
	240 kHz	Case E	22390 - <2> - 22556
n258	120 kHz	Case D	22257 - <1> - 22443
	240 kHz	Case E	22258 - <2> - 22442
n260	120 kHz	Case D	22995 - <1> - 23166
	240 kHz	Case E	22996 - <2> - 23164
n261	120 kHz	Case D	22446 - <1> - 22492
	240 kHz	Case E	22446 - <2> - 22490
NOTE 1: SS Block pattern is defined in subclause 4.1 in TS 38.213 [10].			

5.4A Channel arrangement for CA

5.4A.1 Channel spacing for CA

<Editor's note: Table and chapter number to be updated>

For intra-band contiguous carrier aggregation with two or more component carriers, the nominal channel spacing between two adjacent NR component carriers is defined as the following unless stated otherwise:

For NR operating bands with 60kHz channel raster:

$$\text{Nominal channel spacing} = \left\lfloor \frac{BW_{Channel(1)} + BW_{Channel(2)} - 2\left|GB_{Channel(1)} - GB_{Channel(2)}\right|}{0.06 * 2^{n+1}} \right\rfloor 0.06 * 2^{n} \text{ [MHz]}$$

with

$$n = \max(\mu_1, \mu_2) - 2$$

where $BW_{Channel(1)}$ and $BW_{Channel(2)}$ are the channel bandwidths of the two respective NR component carriers according to Table 5.3.2-1 with values in MHz. and the $GB_{Channel(i)}$ is the minimum guard band defined in sub-clause 5.3.3, while μ_1 and μ_2 are the subcarrier spacing configurations of the component carriers as defined in TS 38.211 [9]. The channel spacing for intra-band contiguous carrier aggregation can be adjusted to any multiple of sub-carrier spacing less than the nominal channel spacing to optimize performance in a particular deployment scenario.

For intra-band non-contiguous carrier aggregation, the channel spacing between two NR component carriers in different sub-blocks shall be larger than the nominal channel spacing defined in this subclause.

5.5 Configurations

5.5A Configurations for CA

5.5A.1 Configurations for intra-band contiguous CA

Table 5.5A.1-2: NR CA configurations and bandwidth combination sets defined for intra-band contiguous CA

		NR CA configuration / Bandwidth combination set										
NR CA configuration	Uplink CA configurations	Component carriers in order of increasing carrier frequency								Aggregated BW (MHz)	BCS	Fallback group
		CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)			
CA_257B		50	400							450	0	1
		100	400							500		
		200	400							600		
		400	400							800		
CA_257D		50	200							250	0	2
		100	200							300		
		200	200							400		

		NR CA configuration / Bandwidth combination set										
NR CA configuration	Uplink CA configurations	Component carriers in order of increasing carrier frequency								Aggregated BW (MHz)	BCS	Fallback group
		CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)			
CA_257E		50	200	200						450	0	
		100	200	200						500		
		200	200	200						600		
CA_257F		50	200	200	200					650	0	
		100	200	200	200					700		
		200	200	200	200					800		
CA_257G		100	100							200	0	3
CA_257H		100	100	100						300	0	
CA_257I		100	100	100	100					400	0	
CA_257J		100	100	100	100	100				500	0	
CA_257K		100	100	100	100	100	100			600	0	
CA_257L		100	100	100	100	100	100	100		700	0	
CA_257M		100	100	100	100	100	100	100	100	800	0	
CA_n260B		50, 100, 200, 400	400							800	0	1
CA_n260C		50, 100, 200, 400	400	400						1200	0	
CA_n260D		50, 100, 200	200							400	0	2
CA_n260E		50, 100, 200	200	200						600	0	
CA_n260F		50, 100, 200	200	200	200					800	0	
CA_n260G		100	50, 100							200	0	3
CA_n260H		100	100	50, 100						300	0	
CA_n260I		100	100	100	50, 100					400	0	
CA_n260J		100	100	100	100	50, 100				500	0	
CA_n260K		100	100	100	100	100	50, 100			600	0	
CA_n260L		100	100	100	100	100	100	50, 100		700	0	
CA_n260M		100	100	100	100	100	100	100	50, 100	800	0	
CA_n260O		50, 100	50, 100							200	0	4
CA_n260P		50, 100	50, 100	50, 100						300	0	
CA_n260Q		50, 100	50, 100,	50, 100	50, 100					400	0	
CA_n261B		50, 100, 200, 400	400							800	0	1

		NR CA configuration / Bandwidth combination set										
NR CA configuration	Uplink CA configurations	Component carriers in order of increasing carrier frequency								Aggregated BW (MHz)	BCS	Fallback group
		CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)			
CA_n261C		50, 100, 200, 400	400	400						1200	0	
CA_n261D		50, 100, 200	200							400	0	2
CA_n261E		50, 100, 200	200	200						600	0	
CA_n261F		50, 100, 200	200	200	200					800	0	
CA_n261G		100	50, 100							200	0	3
CA_n261H		100	100	50, 100						300	0	
CA_n261I		100	100	100	50, 100					400	0	
CA_n261J		100	100	100	100	50, 100				500	0	
CA_n261K		100	100	100	100	100	50, 100			600	0	
CA_n261L		100	100	100	100	100	100	50, 100		700	0	
CA_n261M		100	100	100	100	100	100	100	50, 100	800	0	
CA_n261O		50, 100	50, 100							200	0	4
CA_n261P		50, 100	50, 100	50, 100						300	0	
CA_n261Q		50, 100	50, 100,	50, 100	50, 100					400	0	

5.5A.2 Configurations for intra-band non-contiguous CA

Table 5.5A.2-1: NR CA configurations and bandwidth combination sets defined for intra-band non-contiguous CA

			NR CA configuration / Bandwidth combination set						
NR configuration	Uplink CA configurations	SCS	Component carriers in order of increasing carrier frequency					Maximum aggregated bandwidth (MHz)	Fallback group
			Channel bandwidths for carrier (MHz)	Channel bandwidths for carrier (MHz)	Channel bandwidths for carrier (MHz)	Channel bandwidths for carrier (MHz)	Channel bandwidths for carrier (MHz)		
CA_n257(2A)	-	60	50, 100, 200	50, 100, 200				400	
		120	50, 100, 200, 400	50, 100, 200, 400				800	
CA_n260(2A)	-	60	50, 100, 200	50, 100, 200				400	
		120	50, 100, 200, 400	50, 100, 200, 400				800	
CA_n260(3A)	-	60	50, 100, 200	50, 100, 200	50, 100, 200			600	
		120	50, 100, 200, 400	50, 100, 200, 400	50, 100, 200, 400			1200	
CA_n260(4A)	-	60	50, 100, 200	50, 100, 200	50, 100, 200	50, 100, 200		800	
		120	50, 100, 200, 400	50, 100, 200, 400	50, 100, 200, 400	50, 100, 200, 400		1600	
CA_n261(2A)	-	60	50, 100, 200	50, 100, 200				400	
		120	50, 100, 200, 400	50, 100, 200, 400				800	
CA_n261(3A)	-	60	50, 100, 200	50, 100, 200	50, 100, 200			600	
		120	50, 100, 200, 400	50, 100, 200, 400	50, 100, 200, 400			1200	
CA_n261(4A)	-	60	50, 100, 200	50, 100, 200	50, 100, 200	50, 100, 200		800	
		120	50, 100, 200, 400	50, 100, 200, 400	50, 100, 200, 400	50, 100, 200, 400		1600	

Table 5.5A.2-2: NR CA configurations and bandwidth combination fallback group defined for non-contiguous intra-band CA

		NR CA configuration / Bandwidth combination set					
CA configuration	Uplink CA configurations (NOTE 1)	Component carriers in order of increasing carrier frequency					Maximum aggregated bandwidth (MHz)
		Channel bandwidths for carrier (MHz)	Channel bandwidths for carrier (MHz)	Channel bandwidths for carrier (MHz)	Channel bandwidths for carrier (MHz)	Channel bandwidths for carrier (MHz)	
CA_n260(D-G)	-	See CA_n260D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		See CA_n260G Bandwidth Combination Fallback group 3 in Table 6.X.2-2			600
		See CA_n260G Bandwidth Combination Fallback group 3 in Table 6.X.2-2			See CA_n260D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		
CA_n260(D-H)	-	See CA_n260D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		See CA_n260H Bandwidth Combination Fallback group 3 in Table 6.X.2-2			700
		See CA_n260H Bandwidth Combination Fallback group 3 in Table 6.X.2-2			See CA_n260D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		
CA_n260(D-I)	-	See CA_n260D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		See CA_n260I Bandwidth Combination Fallback group 3 in Table 6.X.2-2			800
		See CA_n260I Bandwidth Combination Fallback group 3 in Table 6.X.2-2			See CA_n260D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		
CA_n260(D-O)	-	See CA_n260D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		See CA_n260O Bandwidth Combination Fallback group 4 in Table 6.X.2-1			600
		See CA_n260O Bandwidth Combination Fallback group 4 in Table 6.X.2-1			See CA_n260D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		
CA_n260(D-P)	-	See CA_n260D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		See CA_n260P Bandwidth Combination Fallback group 4 in Table 6.X.2-1			700
		See CA_n260P Bandwidth Combination Fallback group 4 in Table 6.X.2-1			See CA_n260D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		
CA_n260(D-Q)	-	See CA_n260D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		See CA_n260Q Bandwidth Combination Fallback group 4 in Table 6.X.2-1			800
		See CA_n260Q Bandwidth Combination Fallback group 4 in Table 6.X.2-1			See CA_n260D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		
CA_n260(E-O)	-	See CA_n260E Bandwidth Combination Fallback group 2 in Table 6.X.2-1		See CA_n260O Bandwidth Combination Fallback group 4 in Table 6.X.2-1			800
		See CA_n260O Bandwidth Combination Fallback group 4 in Table 6.X.2-1			See CA_n260E Bandwidth Combination Fallback group 2 in Table 6.X.2-1		
CA_n260(E-P)	-	See CA_n260E Bandwidth Combination Fallback group 2 in Table 6.X.2-1		See CA_n260P Bandwidth Combination Fallback group 4 in Table 6.X.2-1			900
		See CA_n260P Bandwidth Combination Fallback group 4 in Table 6.X.2-1			See CA_n260E Bandwidth Combination Fallback group 2 in Table 6.X.2-1		
CA_n260(E-Q)	-	See CA_n260E Bandwidth Combination Fallback group 2 in Table 6.X.2-1		See CA_n260Q Bandwidth Combination Fallback group 4 in Table 6.X.2-1			1000
		See CA_n260Q Bandwidth Combination Fallback group 4 in Table 6.X.2-1			See CA_n260E Bandwidth Combination Fallback group 2 in Table 6.X.2-1		
CA_n261(D-G)	-	See CA_n261D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		See CA_n261G Bandwidth Combination Fallback group 3 in Table 6.X.2-2			600
		See CA_n261G Bandwidth Combination Fallback group 3 in Table 6.X.2-2			See CA_n261D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		

		NR CA configuration / Bandwidth combination set					
		Component carriers in order of increasing carrier frequency					
CA configuration	Uplink CA configurations (NOTE 1)	Channel bandwidths for carrier (MHz)	Channel bandwidths for carrier (MHz)	Channel bandwidths for carrier (MHz)	Channel bandwidths for carrier (MHz)	Channel bandwidths for carrier (MHz)	Maximum aggregated bandwidth (MHz)
CA_n261(D-H)	-	See CA_n261D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		See CA_n261H Bandwidth Combination Fallback group 3 in Table 6.X.2-2			700
		See CA_n261H Bandwidth Combination Fallback group 3 in Table 6.X.2-2			See CA_n261D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		
CA_n261(D-I)	-	See CA_n261D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		See CA_n261I Bandwidth Combination Fallback group 3 in Table 6.X.2-2			800
		See CA_n261I Bandwidth Combination Fallback group 3 in Table 6.X.2-2			See CA_n261D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		
CA_n261(D-O)	-	See CA_n261D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		See CA_n261O Bandwidth Combination Fallback group 4 in Table 6.X.2-1			600
		See CA_n261O Bandwidth Combination Fallback group 4 in Table 6.X.2-1			See CA_n261D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		
CA_n261(D-P)	-	See CA_n261D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		See CA_n261P Bandwidth Combination Fallback group 4 in Table 6.X.2-1			700
		See CA_n261P Bandwidth Combination Fallback group 4 in Table 6.X.2-1			See CA_n261D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		
CA_n261(D-Q)	-	See CA_n261D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		See CA_n261Q Bandwidth Combination Fallback group 4 in Table 6.X.2-1			800
		See CA_n261Q Bandwidth Combination Fallback group 4 in Table 6.X.2-1			See CA_n261D Bandwidth Combination Fallback group 2 in Table 6.X.2-1		
CA_n261(E-O)	-	See CA_n261E Bandwidth Combination Fallback group 2 in Table 6.X.2-1		See CA_n261O Bandwidth Combination Fallback group 4 in Table 6.X.2-1			800
		See CA_n261O Bandwidth Combination Fallback group 4 in Table 6.X.2-1			See CA_n261E Bandwidth Combination Fallback group 2 in Table 6.X.2-1		
CA_n261(E-P)	-	See CA_n261E Bandwidth Combination Fallback group 2 in Table 6.X.2-1		See CA_n261P Bandwidth Combination Fallback group 4 in Table 6.X.2-1			900
		See CA_n261P Bandwidth Combination Fallback group 4 in Table 6.X.2-1			See CA_n261E Bandwidth Combination Fallback group 2 in Table 6.X.2-1		
CA_n261(E-Q)	-	See CA_n261E Bandwidth Combination Fallback group 2 in Table 6.X.2-1		See CA_n261Q Bandwidth Combination Fallback group 4 in Table 6.X.2-1			1000
		See CA_n261Q Bandwidth Combination Fallback group 4 in Table 6.X.2-1			See CA_n261E Bandwidth Combination Fallback group 2 in Table 6.X.2-1		

5.5D Configurations for UL-MIMO

The requirements specified in subclause 5.5 are applicable to UE supporting UL-MIMO.

6 Transmitter characteristics

6.1 General

Unless otherwise stated, the transmitter characteristics are specified over the air (OTA) with a single or multiple transmit chains.

6.2 Transmitter power

6.2.1 UE maximum output power

6.2.1.1 UE maximum output power for power class 1

The following requirements define the maximum output power radiated by the UE for any transmission bandwidth within the channel bandwidth for non-CA configuration, unless otherwise stated. The period of measurement shall be at least one sub frame (1ms). The requirement is verified with the test metric of EIRP (Link=Beam peak search grids, Meas=Link angle). Power class 1 UE is used for fixed wireless access (FWA).

Table 6.2.1.1-1: UE minimum peak EIRP for power class 1

Operating band	Min peak EIRP (dBm)
n257	40.0
n258	40.0
n260	38.0
n261	40.0
NOTE 1: Minimum peak EIRP is defined as the lower limit without tolerance	

The maximum output power values for TRP and EIRP are found in Table 6.2.1.1-2 below. The maximum allowed EIRP is derived from regulatory requirements [8]. The requirements are verified with the test metrics of TRP (Link=TX beam peak direction) in beam locked mode and EIRP (Link=TX beam peak direction, Meas=Link angle).

Table 6.2.1.1-2: UE maximum output power limits for power class 1

Operating band	Max TRP (dBm)	Max EIRP (dBm)
n257	35	55
n258	35	55
n260	35	55
n261	35	55

The minimum EIRP at the 85^{th} percentile of the distribution of radiated power measured over the full sphere around the UE is defined as the spherical coverage requirement and is found in Table 6.2.1.1-3 below. The requirement is verified with the test metric of EIRP (Link=Beam peak search grids, Meas=Link angle).

Table 6.2.1.1-3: UE spherical coverage for power class 1

Operating band	Min EIRP at 85%-tile CDF (dBm)
n257	32.0
n258	32.0
n260	30.0
n261	32.0
NOTE 1: Minimum EIRP at 85%-tile CDF is defined as the lower limit without tolerance	

6.2.1.2 UE maximum output power for power class 2

The following requirements define the maximum output power radiated by the UE for any transmission bandwidth within the channel bandwidth for non-CA configuration, unless otherwise stated. The period of measurement shall be at least one sub frame (1ms). The requirement is verified with the test metric of EIRP (Link=Beam peak search grids, Meas=Link angle).

Table 6.2.1.2-1: UE minimum peak EIRP for power class 2

Operating band	Min peak EIRP (dBm)
n257	29
n258	29
n260	
n261	29
NOTE 1: Minimum peak EIRP is defined as the lower limit without tolerance	

The maximum output power values for TRP and EIRP are found in Table 6.2.1.2-2 below. The maximum allowed EIRP is derived from regulatory requirements [8]. The requirements are verified with the test metrics of TRP (Link=TX beam peak direction) in beam locked mode and EIRP (Link=TX beam peak direction, Meas=Link angle).

Table 6.2.1.2-2: UE maximum output power limits for power class 2

Operating band	Max TRP (dBm)	Max EIRP (dBm)
n257	23	43
n258	23	43
n260		
n261	23	43

The minimum EIRP at the 60th percentile of the distribution of radiated power measured over the full sphere around the UE is defined as the spherical coverage requirement and is found in Table 6.2.1.2-3 below. The requirement is verified with the test metric of EIRP (Link=Beam peak search grids, Meas=Link angle).

Table 6.2.1.2-3: UE spherical coverage for power class 2

Operating band	Min EIRP at 60%-tile CDF (dBm)
n257	18.0
n258	18.0
n260	
n261	18.0
NOTE 1: Minimum EIRP at 60%-tile CDF is defined as the lower limit without tolerance	

6.2.1.3 UE maximum output power for power class 3

The following requirements define the maximum output power radiated by the UE for any transmission bandwidth within the channel bandwidth for non-CA configuration, unless otherwise stated. The period of measurement shall be at least one sub frame (1ms). The values listed on the table below are for handheld UE, defined as minimum peak EIRP. The requirement is verified with the test metric of EIRP (Link=Beam peak search grids, Meas=Link angle).

Table 6.2.1.3-1: UE minimum peak EIRP for power class 3

Operating band	Min peak EIRP (dBm)
n257	22.4
n258	22.4
n260	20.6
n261	22.4
NOTE 1: Minimum peak EIRP is defined as the lower limit without tolerance	

The maximum output power values for TRP and EIRP are found on the Table6.2.1.3-2. The max allowed EIRP is derived from regulatory requirements [8]. The requirements are verified with the test metrics of TRP (Link=TX beam peak direction) in beam locked mode and EIRP (Link=TX beam peak direction, Meas=Link angle).

Table 6.2.1-2: UE maximum output power limits for power class 3

Operating band	Max TRP (dBm)	Max EIRP (dBm)
n257	23	43
n258	23	43
n260	23	43
n261	23	43

The minimum EIRP at the 50th percentile of the distribution of radiated power measured over the full sphere around the UE is defined as the spherical coverage requirement and is found in Table 6.2.1.3-3 below. The requirement is verified with the test metric of EIRP (Link=Beam peak search grids, Meas=Link angle).

Table 6.2.1.3-3: UE spherical coverage for power class 3

Operating band	Min EIRP at 50t%-tile CDF (dBm)
n257	11.5
n258	11.5
n260	8
n261	11.5
NOTE 1: Minimum EIRP at 50 %-tile CDF is defined as the lower limit without tolerance NOTE 2: The requirements in this table are only applicable for UE which supports single band in FR2	

6.2.1.4 UE maximum output power for power class 4

The following requirements define the maximum output power radiated by the UE for any transmission bandwidth within the channel bandwidth for non-CA configuration, unless otherwise stated. The period of measurement shall be at least one sub frame (1ms). The requirement is verified with the test metric of EIRP (Link=Beam peak search grids, Meas=Link angle).

Table 6.2.1.4-1: UE minimum peak EIRP for power class 4

Operating band	Min peak EIRP (dBm)
n257	34
n258	34
n260	31
n261	34
NOTE 1: Minimum peak EIRP is defined as the lower limit without tolerance	

The maximum output power values for TRP and EIRP are found in Table 6.2.1.2-2 below. The maximum allowed EIRP is derived from regulatory requirements [8]. The requirements are verified with the test metrics of TRP (Link=TX beam peak direction) in beam locked mode and EIRP (Link=TX beam peak direction, Meas=Link angle).

Table 6.2.1.4-2: UE maximum output power limits for power class 4

Operating band	Max TRP (dBm)	Max EIRP (dBm)
n257	23	43
n258	23	43
n260	23	43
n261	23	43

The minimum EIRP at the 20th percentile of the distribution of radiated power measured over the full sphere around the UE is defined as the spherical coverage requirement and is found in Table 6.2.1.4-3 below. The requirement is verified with the test metric of EIRP (Link=Beam peak search grids, Meas=Link angle).

Table 6.2.1.4-3: UE spherical coverage for power class 4

Operating band	Min EIRP at 20%-tile CDF (dBm)
n257	25
n258	25
n260	19
n261	25
NOTE 1: Minimum EIRP at 20%-tile CDF is defined as the lower limit without tolerance	

6.2.2 UE maximum output power reduction

6.2.2.1 UE maximum output power reduction for power class 1

Power class 1 UE is allowed to reduce the maximum output power due to modulation orders, transmit bandwidth configurations, waveform types and narrow allocations, denoted as MPR = max(MPR_{WT}, MPR_{narrow}), in which MPR_{narrow} is the maximum output power reduction due to narrow PRB allocations and MPR_{WT} is the maximum power reduction due to modulation orders, transmit bandwidth configurations, waveform types. MPR_{narrow} shall be up to [10] dB for pi/2 BPSK and higher modulations when total contiguous allocated RBs is less than or equal to 10 MHz, and MPR_{WT} is defined in Table 6.2.2.1-1

Table 6.2.2.1-1 MPR_{WT} for power class 1

Modulation	MPR_{WT} (dB)	
	Outer RB allocations	Inner RB allocations
DFT-s-OFDM PI/2 BPSK	≤ [5.5]	≤ [2.5]
DFT-s-OFDM QPSK	≤ [6.5]	≤ [3]
DFT-s-OFDM 16 QAM	≤ [6.5]	≤ [4]
DFT-s-OFDM 64 QAM	≤ [6.5]	≤ [4.5]
CP-OFDM QPSK	≤ [6.5]	≤ [4.5]
CP-OFDM 16 QAM	≤ [6.5]	≤ [5.5]
CP-OFDM 64 QAM	≤ [7]	≤ [7]

Where the following parameters are defined to specify valid RB allocation ranges for Outer and Inner RB allocations:

N_{RB} is the maximum number of RBs for a given Channel bandwidth and sub-carrier spacing defined in Table 5.3.2-1.

$$RB_{Start,Low} = \max(1, \text{floor}(L_{CRB}/2))$$

where max() indicates the largest value of all arguments and floor(x) is the greatest integer less than or equal to x.

$$RB_{Start,High} = L_{RB} - RB_{Start,Low} - L_{CRB}$$

The RB allocation is an Inner RB allocation if the following conditions are met

$$RB_{Start,Low} \leq RB_{Start} \leq RB_{Start,High,}$$

and

$$L_{CRB} \leq \text{ceil}(N_{RB}/2)$$

where ceil(x) is the smallest integer greater than or equal to x.

The RB allocation is an Outer RB allocation for all other allocations which are not an Inner RB allocation.

The waveform defined by BW = 100 MHz, SCS = 60 kHz, DFT-S-OFDM QPSK, 128RB0 is the reference waveform with 0 dB MPR and is used for the power class definition.

UE requirements for the waveform defined by BW = 100 MHz, SCS = 60 kHz, DFT-S-OFDM pi/2 BPSK, 128RB0 shall be set to 0 dB MPR.

For the UE maximum output power modified by MPR, the power limits specified in subclause 6.2.4 apply.

6.2.2.2 UE maximum output power reduction for power class 2

6.2.2.3 UE maximum output power reduction for power class 3

Power class 3 UE is allowed to reduce the maximum output power due to higher order modulations and transmit bandwidth configurations. For UE, the allowed maximum power reduction (MPR) is defined in Table 6.2.2.3-1.

Table 6.2.2.3-1 Maximum power reduction (MPR) for UE

		Channel Bandwidth / MPR	
		50 / 100 / 200 MHz	400 MHz
DFT-s-OFDM	Pi/2 BPSK	TBD	TBD
	QPSK	TBD	TBD
	16QAM	TBD	TBD
	64QAM	TBD	TBD
CP-OFDM	QPSK	TBD	TBD
	16QAM	TBD	TBD
	64QAM	TBD	TBD

The waveform defined by TBD is the reference waveform with 0dB MPR and is used for the power class definition.

UE requirements for the waveform defined by TBD shall be set to 0dB MPR.

For the UE maximum output power modified by MPR, the power limits specified in subclause 6.2.4 apply.

6.2.2.4 UE maximum output power reduction for power class 4

6.2.3 UE maximum output power with additional requirements

Detailed content of the subclause is TBD.

6.2.4 Configured transmitted power

The UE can configure its maximum output power. The configured UE maximum output power $P_{CMAX,f,c}$ for carrier f of a serving cell c is defined as that available to the reference point of a given transmitter branch that corresponds to the reference point of the higher-layer filtered RSRP measurement in each receiver branch as specified in 38.215.

The configured UE maximum output power $P_{CMAX,f,c}$ for carrier *f* of a serving cell *c* shall be set such that the corresponding measured peak EIRP $P_{UMAX,f,c}$ is within the following bounds

$$P_{Powerclass} – MPR_{f,c} – P\text{-}MPR_{f,c} – T(MPR_{f,c} + P\text{-}MPR_{f,c}) \leq P_{UMAX,f,c} \leq EIRP_{max}$$

while the corresponding measured total radiated power $P_{TMAX,f,c}$ is bounded by

$$P_{TMAX,f,c} \leq TRP_{max}$$

with $P_{Powerclass}$ the UE power class as specified in sub-clause 6.2.1, $EIRP_{max}$ the applicable maximum EIRP as specified in sub-clause 6.2.1, $MPR_{f,c}$ as specified in sub-clause 6.2.2, $P\text{-}MPR_{f,c}$ the power management term for the UE and TRP_{max} the maximum TRP for the UE power class as specified in sub-clause 6.2.1. The tolerance $T(\Delta P)$ for applicable values of ΔP (values in dB) is specified in Table 6.2.4-1.

Table 6.2.4-1: $P_{UMAX,f,c}$ tolerance

Operating Band	ΔP (dB)	Tolerance T(ΔP) (dB)
n257, n258, n260, n261	ΔP = [0]	0
	[0] < ΔP ≤ [1.5]	[0.5]
	[1.5] < ΔP ≤ [2.5]	[1]
	[2.5] < ΔP ≤ [3.5]	[2]
	[3.5] < ΔP ≤ [4.5]	[3]
	[4.5] < ΔP ≤ [9.5]	[4]
	[9.5] < ΔP ≤ [14.5]	[5]
	[14.5] < ΔP ≤ [35.5]	[6]

6.2A Transmitter power for CA

6.2A.1 UE maximum output power for CA

For downlink intra-band contiguous and non-contiguous carrier aggregation with a single uplink component carrier configured in the NR band, the maximum output power is specified in Table 6.2.1-1.

For uplink intra-band contiguous carrier aggregation for any CA bandwidth class, the maximum output power is specified in Table 6.2.1-1

6.2A.2 UE maximum output power reduction for CA

For intra-band contiguous carrier aggregation, UE is allowed to reduce the maximum output power due to higher order modulations and transmit bandwidth configurations for aggregated bandwidth less than 400 MHz. The allowed maximum power reduction (MPR) is defined in Table 6.2A.2-1. The requirement is defined for 2 equal, contiguous CCs, with a single contiguous RB allocation that encloses the inter-CC gap, and with the same type of waveform in both CCs.

Table 6.2A.2-1 Maximum power reduction (MPR) for UE

		Aggregated channel bandwidth
		< 400MHz
DFT-s-OFDM	Pi/2 BPSK	[5.0]
	QPSK	[5.0]
	16 QAM	[6.0]
	64 QAM	[8.5]
CP-OFDM	QPSK	[5.0]
	16 QAM	[6.0]
	64 QAM	[8.5]

For the UE maximum output power modified by MPR, the power limits specified in subclause 6.2A.4 apply.

6.2D Transmitter power for UL-MIMO

6.2D.1 UE maximum output power for UL-MIMO

6.2D.1.3 UE maximum output power for UL-MIMO for power class 3

The following requirements define the maximum output power radiated by the UE with UL-MIMO for any transmission bandwidth within the channel bandwidth for non-CA configuration, unless otherwise stated. Requirements in Table 6.2D.1.3-1 shall be met with the UL-MIMO configurations specified in Table 6.2D.1.3-3. The period of measurement shall be at least one sub frame (1ms). The requirement is verified with the test metric of EIRP (Link=Beam peak search grids, Meas=Link angle).

Table 6.2D.1.3-1: UE minimum peak EIRP for UL-MIMO for power class 3

Operating band	Min peak EIRP (dBm)	Maximum allowed total TRP (dBm)
n257	22.4	23
NOTE 1: Minimum peak EIRP is defined as the lower limit without tolerance. NOTE 2: Min Peak EIRP refers to the total EIRP for the UL beams peaks.		

The maximum output power values for TRP and EIRP are found in Table 6.2D.1.3-2 below. The maximum allowed EIRP is derived from regulatory requirements [8]. The requirements are verified with the test metrics of TRP (Link=TX beam peak direction) in beam locked mode and EIRP (Link=TX beam peak direction, Meas=Link angle).

Table 6.2D.1.3-2: UE maximum output power limits for UL-MIMO for power class 3

Operating band	Max TRP (dBm)	Max EIRP (dBm)
n257	23	43

Table 6.2D.1.3-3: UL-MIMO configuration

Transmission scheme	DCI format	Codebook Index
Codebook based uplink	DCI format 0_1	Codebook index 0

6.2D.2 UE maximum output power for modulation / channel bandwidth for UL-MIMO

For UE with UL-MIMO, the allowed Maximum Power Reduction (MPR) for the maximum output power in Table 6.2D.1.3-1 is specified in Table 6.2.2-1. The requirements shall be met with UL-MIMO configurations specified in Table 6.2D.1.3-3.

For the UE maximum output power modified by MPR, the power limits specified in subclause 6.2D.4 apply.

6.2D.3 UE maximum output power with additional requirements for UL-MIMO

For UE with UL-MIMO, the A-MPR values specified in subclause 6.2.3 shall apply to the maximum output power specified in Table 6.2D.1.3-1. The requirements shall be met with the UL-MIMO configurations specified in Table 6.2D.1.3-3.

For the UE maximum output power modified by A-MPR, the power limits specified in subclause 6.2D.4 apply.

6.2D.4 Configured transmitted power for UL-MIMO

Detailed content of the subclause is 6.2.4 after defining the general requirement in subclause 6.2.4.

6.3 Output power dynamics

6.3.1 Minimum output power

The minimum controlled output power of the UE is defined as the EIRP in the channel bandwidth for all transmit bandwidth configurations (resource blocks) when the power is set to a minimum value.

6.3.1.1 Minimum output power for power class 1

For power class 1 UE, the minimum output power shall not exceed the values specified in Table 6.3.1.1-1 for each operating band supported. The minimum power is verified in beam locked mode with the test metric of EIRP (Link=TX beam peak direction, Meas=Link angle).

Table 6.3.1.1-1: Minimum output power for power class 1

Operating band	Channel bandwidth (MHz)	Minimum output power (dBm)	Measurement bandwidth (MHz)
n257, n258, n260, n261	50	4	47.52
	100	4	95.04
	200	4	190.08
	400	4	380.16

6.3.1.2 Minimum output power for power class 2, 3, and 4

The minimum output power shall not exceed the values specified in Table 6.3.1.2-1 for each operating band supported. The minimum power is verified in beam locked mode with the test metric of EIRP (Link=TX beam peak direction, Meas=Link angle).

Table 6.3.2-1: Minimum output power for power class 2, 3, and 4

Operating band	Channel bandwidth (MHz)	Minimum output power (dBm)	Measurement bandwidth (MHz)
n257, n258, n260, n261	50	-13	47.52
	100	-13	95.04
	200	-13	190.08
	400	-13	380.16

6.3.2 Transmit OFF power

The transmit OFF power is defined as the TRP in the channel bandwidth when the transmitter is OFF. The transmitter is considered OFF when the UE is not allowed to transmit or during periods when the UE is not transmitting a sub-frame. During DTX and measurements gaps, the transmitter is not considered OFF.

The transmit OFF power shall not exceed the values specified in Table 6.3.2-1 for each operating band supported. The requirement is verified with the test metric of TRP (Link=TX beam peak direction).

Table 6.3.2-1: Transmit OFF power

Operating band	Channel bandwidth / Transmit OFF power (dBm) / measurement bandwidth			
	50 MHz	**100 MHz**	**200 MHz**	**400 MHz**
n257, n258, n260, n261	-35	-35	-35	-35
	47.52 MHz	95.04 MHz	190.08 MHz	380.16 MHz

6.3.3 Transmit ON/OFF time mask

6.3.3.1 General

The transmit ON/OFF time mask defines the transient period(s) allowed

- between transmit OFF power and transmit ON power symbols (transmit ON/OFF)

Unless otherwise stated the minimum requirements in clause 6 apply also in transient periods.

The transmit ON/OFF time mask is defined as a directional requirement. The requirement is verified in beam locked mode at beam peak direction. The maximum allowed EIRP OFF power level is -30dBm at beam peak direction. The requirement is verified with the test metric of EIRP (Link=TX beam peak direction, Meas=Link angle).

In the following sub-clauses, following definitions apply:

- A slot transmission is a Type A transmission.
- A long subslot transmission is a Type B transmission with more than 2 symbols.
- A short subslot transmission is a Type B transmission with 1 or 2 symbols.

6.3.3.2 General ON/OFF time mask

The general ON/OFF time mask defines the observation period allowed between transmit OFF and ON power. ON/OFF scenarios include: the beginning or end of DTX, measurement gap, contiguous, and non-contiguous transmission, etc

The OFF power measurement period is defined in a duration of at least one slot excluding any transient periods. The ON power is defined as the mean power over one slot excluding any transient period.

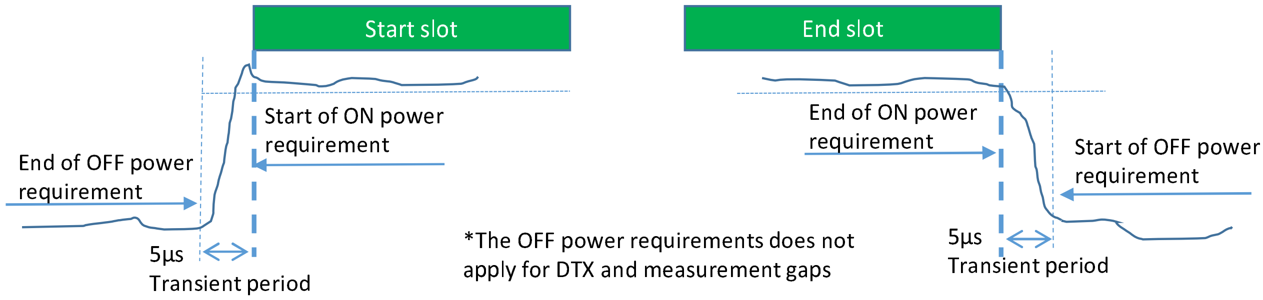

Figure 6.3.3.2-1: General ON/OFF time mask for NR UL transmission in FR2

6.3.3.3 Transmit power time mask for slot and short or long subslot boundaries

The transmit power time mask for slot and a long subslot transmission boundaries defines the transient periods allowed between slot and long subslot PUSCH transmissions. For PUSCH-PUCCH and PUSCH-SRS transitions and multiplexing the time masks in sub-clause 6.3.3.7 apply.

The transmit power time mask for slot or long subslot and short subslot transmission boundaries defines the transient periods allowed between slot or long subslot and short subslot transmissions. The time masks in sub-clause 6.3.3.8 apply.

The transmit power time mask for short subslot transmissiona boundaries defines the transient periods allowed between short subslot transmissions. The time masks in sub-clause 6.3.3.9 apply.

6.3.3.4 PRACH time mask

The PRACH ON power is specified as the mean power over the PRACH measurement period excluding any transient periods as shown in Figure 6.3.3.4-1. The measurement period for different PRACH preamble format is specified in Table 6.3.3.4-1.

Table 6.3.3.4-1: PRACH ON power measurement period

PRACH preamble format	Measurement period (ms)
TBD	TBD
TBD	TBD
TBD	TBD
TBD	TBD
TBD	TBD

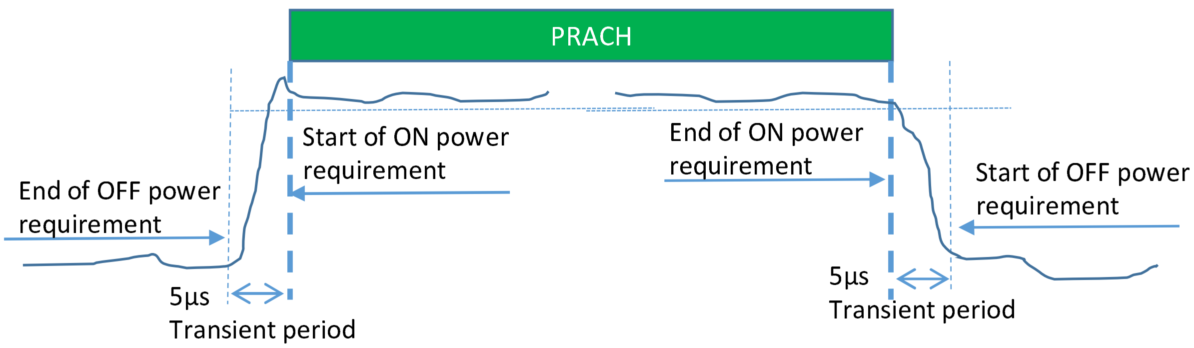

Figure 6.3.3.4-1: PRACH ON/OFF time mask

6.3.3.5 PUCCH time mask

6.3.3.5.1 Long PUCCH time mask

6.3.3.5.2 Short PUCCH time mask

6.3.3.6 SRS time mask

In the case a single SRS transmission, the ON power is defined as the mean power over the symbol duration excluding any transient period; Figure 6.3.3.6-1.

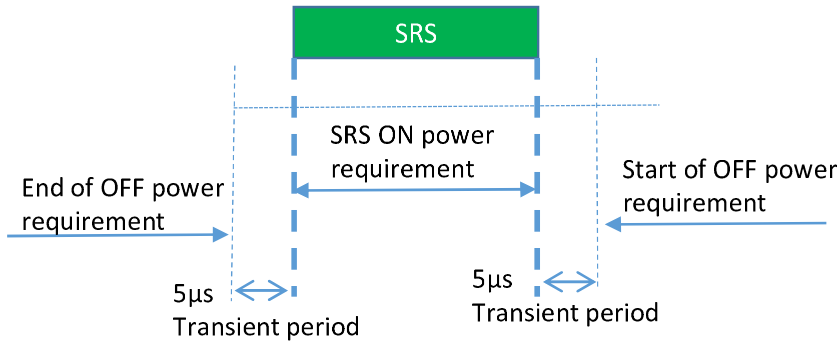

Figure 6.3.3.6-1: Single SRS time mask for NR UL transmission

In the case multiple consecutive SRS transmission, the ON power is defined as the mean power for each symbol duration excluding any transient period. See Figure 7.7.4-2

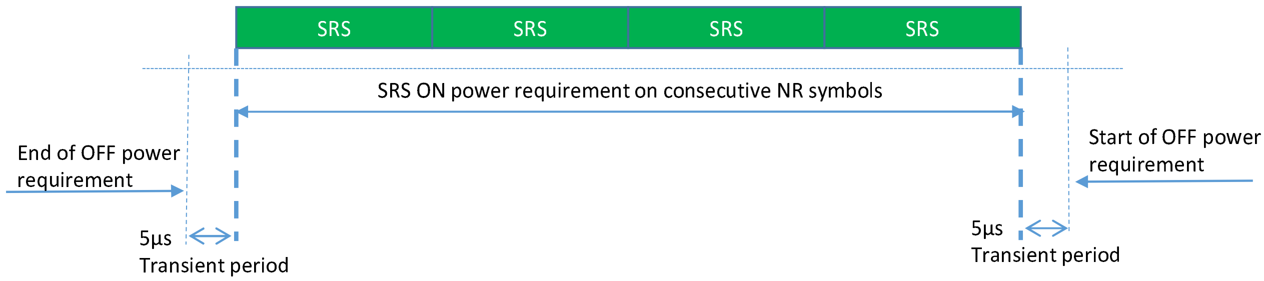

Figure 6.3.3.6-2: Consecutive SRS time mask for the case when no power change is required

When power change between consecutive SRS transmissions is required, then Figure 6.3.3.6-3 and Figure 6.3.3.6-4 apply.

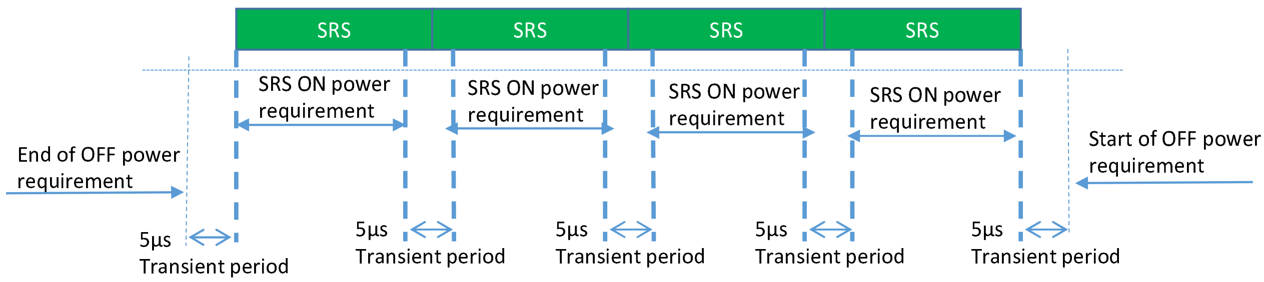

Figure 6.3.3.6-3: Consecutive SRS time mask for the case when power change is required and when 30kHz and 60kHz SCS is used in FR2

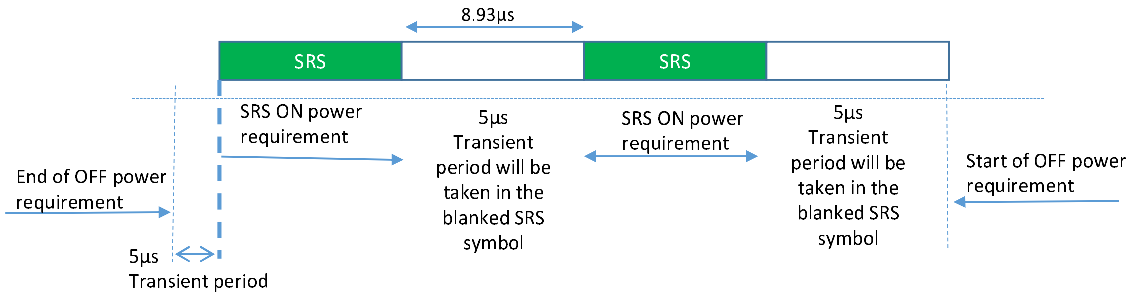

Figure 6.3.3.6-4: Consecutive SRS time mask for the case when power change is required and when 120kHz SCS is used in FR2

6.3.3.7 PUSCH-PUCCH and PUSCH-SRS time masks

The PUCCH/PUSCH/SRS time mask defines the observation period between sounding reference symbol (SRS) and an adjacent PUSCH/PUCCH symbol and subsequent UL transmissions. The time masks apply for all types of frame structures and their allowed PUCCH/PUSCH/SRS transmissions unless otherwise stated.

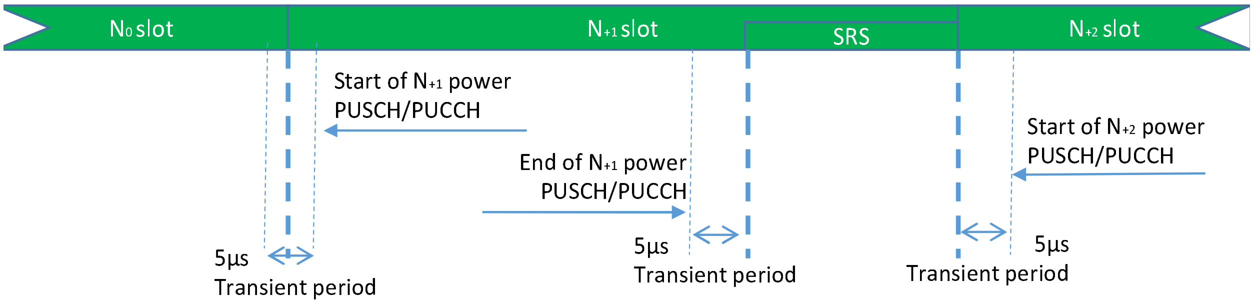

Figure 6.3.3.7-1: PUCCH/PUSCH/SRS time mask when there is a transmission before or after or both before and after SRS

When there is no transmission preceding SRS transmission or succeeding SRS transmission, then the same time mask applies as shown in Figure 6.3.3.7-1.

6.3.3.8 Transmit power time mask for consecutive slot or long subslot transmission and short subslot transmission boundaries

The transmit power time mask for consecutive slot or long subslot transmission and short subslot transmission boundaries defines the transient periods allowed between such transmissions.

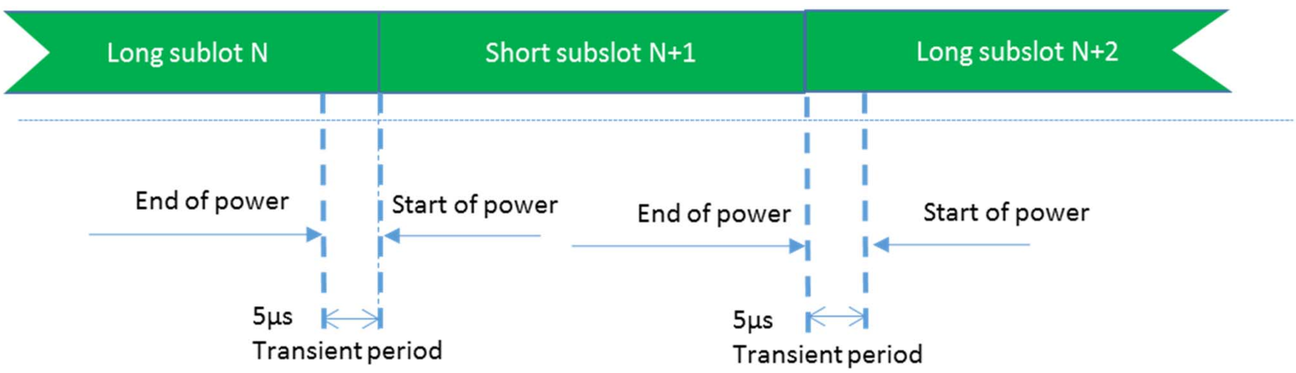

Figure 6.3.3.8-1: Consecutive slot or long subslot transmission and short subslot transmission time mask

6.3.3.9 Transmit power time mask for consecutive short subslot transmissions boundaries

The transmit power time mask for consecutive short subslot transmission boundaries defines the transient periods allowed between short subslot transmissions.

If the first symbol of the consecutive short subslot transmission is DM-RS, the transient period shall be place on the DM-RS symbol as shown on Figure 6.3.3.9-1. Otherwise, the transient period shall be equally shared as shown on figure 6.3.3.9-2

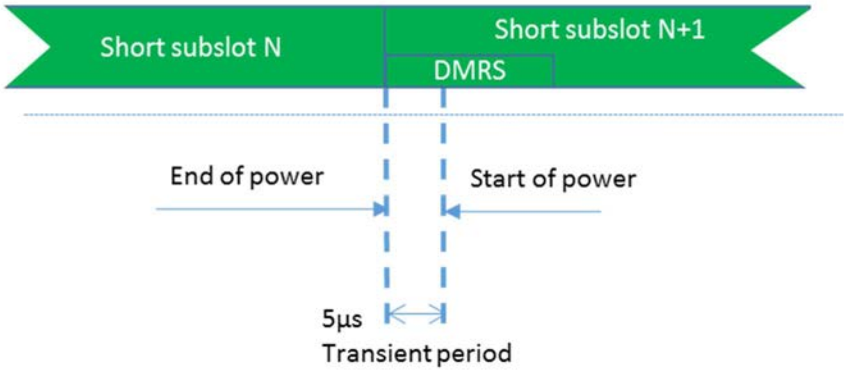

Figure 6.3.3.9-1: Consecutive short subslot transmissions time mask where DMRS is the first symbol in the adjacent short subslot transmission

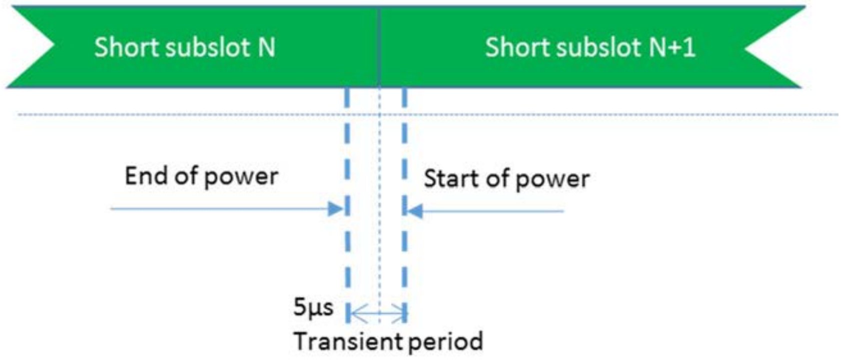

Figure 6.3.3.9-2: Consecutive short subslot transmissions time mask where DMRS is not the first symbol in the adjacent short subslot transmission

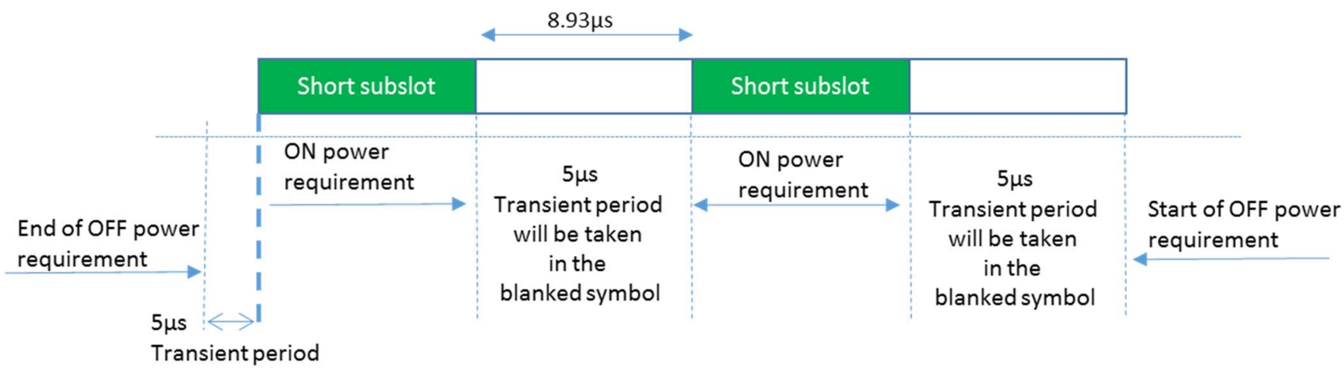

Figure 6.3.3.9-3: Consecutive short subslot (1 symbol gap) time mask for the case when transient period is required on both sides of the symbol and when 120kHz SCS is used in FR2

6.3.4 Power control

6.3.4.1 General

The requirements on power control accuracy apply under normal conditions and are defined as a directional requirement. The requirements are verified in beam locked mode on beam peak direction.

6.3.4.2 Absolute power tolerance

The absolute power tolerance is the ability of the UE transmitter to set its initial output power to a specific value for the first sub-frame at the start of a contiguous transmission or non-contiguous transmission with a transmission gap larger than TBD. The tolerance includes the channel estimation error RSRP estimate.

The minimum requirements specified in Table 6.3.4.2-1 apply in the power range bounded by the minimum output power as specified in sub-clause 6.3.1 ('P_{min}') and the maximum output power as specified in sub-clause 6.2.1 as minimum peak EIRP ('P_{max}'). The intermediate power point 'P_{int}' is defined in table 6.3.4.2-2

Table 6.3.4.2-1: Absolute power tolerance

Power Range	Tolerance
$P_{int} \geq P \geq P_{min}$	± [14.0] dB
$P_{max} \geq P > P_{int}$	± [12.0] dB

Table 6.3.4.2-2: Intermediate power point

Power Parameter	Value
P_{int}	P_{max} – 12.0 dB

6.3.4.3 Relative power tolerance

The relative power tolerance is the ability of the UE transmitter to set its output power in a target sub-frame relatively to the power of the most recently transmitted reference sub-frame if the transmission gap between these sub-frames is TBD.

The minimum requirements specified in Table 6.3.4.3-1 apply when the power of the target and reference sub-frames are within the power range bounded by the minimum output power as defined in sub-clause 6.3.1 and Pint as defined in sub-clause 6.3.4.2. The minimum requirements specified in Table 6.3.4.3-2 apply when the power of the target and reference sub-frames are within the power range bounded by Pint as defined in sub-clause 6.3.4.2 and the measured P_{UMAX} as defined in sub-clause 6.2.4.

Table 6.3.4.3-1: Relative power tolerance, $P_{int} \geq P \geq P_{min}$

Power step ∆P (Up or down) (dB)	All combinations of PUSCH and PUCCH, PUSCH/PUCCH and SRS transitions between sub-frames, PRACH (dB)
ΔP < 2	[±5.0]
2 ≤ ΔP < 3	[±6.0]
3 ≤ ΔP < 4	[±7.0]
4 ≤ ΔP < 10	[±8.0]
10 ≤ ΔP < 15	[±10.0]
15 ≤ ΔP	[±11.0]

Table 6.3.4.3-2: Relative power tolerance, $P_{UMAX} \geq P > P_{int}$

Power step ΔP (Up or down) (dB)	All combinations of PUSCH and PUCCH, PUSCH/PUCCH and SRS transitions between sub-frames, PRACH (dB)
ΔP < 2	[±3.0]
2 ≤ ΔP < 3	[±4.0]
3 ≤ ΔP < 4	[±5.0]
4 ≤ ΔP < 10	[±6.0]
10 ≤ ΔP < 15	[±8.0]
15 ≤ ΔP	[±9.0]

6.3.4.4 Aggregate power tolerance

The aggregate power control tolerance is the ability of the UE transmitter to maintain its power during non-contiguous transmissions within 21ms in response to 0 dB TPC commands with respect to the first UE transmission and all other power control parameters as specified in 38.213 kept constant.

The minimum requirements specified in Table 6.3.4.4-1 apply when the power of the target and reference sub-frames are within the power range bounded by the minimum output power as defined in sub-clause 6.3.1 and P_{int} as defined in sub-clause 6.3.4.2. The minimum requirements specified in Table 6.3.4.4-2 apply when the power of the target and reference sub-frames are within the power range bounded by Pint as defined in sub-clause 6.3.4.2 and the maximum output power as specified in sub-clause 6.2.1.

Table 6.3.4.4-1: Aggregate power tolerance, $P_{int} \geq P \geq P_{min}$

TPC command	UL channel	Aggregate power tolerance within 21ms
0 dB	PUCCH	± [5.5] dB
0 dB	PUSCH	± [5.5] dB

Table 6.3.4.4-2: Aggregate power tolerance, $P_{max} \geq P \geq P_{int}$

TPC command	UL channel	Aggregate power tolerance within 21ms
0 dB	PUCCH	± [3.5] dB
0 dB	PUSCH	± [3.5] dB

6.3A Output power dynamics for CA

6.3A.1 Minimum output power for CA

For intra-band contiguous carrier aggregation, the minimum controlled output power of the UE is defined as the transmit power of the UE per component carrier, i.e., EIRP in the channel bandwidth of each component carrier for all transmit bandwidth configurations (resource blocks), when the power on both component carriers are set to a minimum value.

The minimum output power shall not exceed the values specified in Table 6.3A.1-1 for each operating band supported. The minimum power is verified in beam locked mode with the test metric of EIRP (Link=TX beam peak direction, Meas=Link angle).

Table 6.3A.1-1: Minimum output power for CA

Operating band	Channel bandwidth (MHz)	Minimum output power (dBm)	Measurement bandwidth (MHz)
n257, n258, n260, n261	50	-13	47.52
	100	-13	95.04
	200	-13	190.08
	400	-13	380.16

6.3A.2 Transmit OFF power for CA

For intra-band contiguous carrier aggregation, the transmit OFF power is defined as the TRP in the channel bandwidth per component carrier when the transmitter is OFF. The transmitter is considered OFF when the UE is not allowed to transmit or during periods when the UE is not transmitting a sub-frame. During DTX and measurements gaps, the transmitter is not considered OFF.

The transmit OFF power shall not exceed the values specified in Table 6.3A.2-1 for each operating band supported.

Table 6.3A.2-1: Transmit OFF power for CA

Operating band	Channel bandwidth / Transmit OFF power (dBm) / measurement bandwidth			
	50 MHz	**100 MHz**	**200 MHz**	**400 MHz**
n257, n258, n260, n261	-35	-35	-35	-35
	47.52 MHz	95.04 MHz	190.08 MHz	380.16 MHz

6.3A.3 Transmit ON/OFF time mask for CA

For intra-band contiguous carrier aggregation, the general output power ON/OFF time mask specified in subclause 6.3.3.2 is applicable for each component carrier during the ON power period and the transient periods. The OFF period as specified in subclause 6.3.3.2 shall only be applicable for each component carrier when all the component carriers are OFF.

6.3A.4 Power control for CA

No requirements unique to CA operation are defined.

6.3D Output power dynamics for UL-MIMO

6.3D.1 Minimum output power for UL-MIMO

For UE supporting UL-MIMO, the minimum controlled output power is defined as the EIRP, i.e. the sum of the power in the channel bandwidth for all transmit bandwidth configurations (resource blocks), when the UE power is set to a minimum value. The minimum output power shall not exceed the values specified in Table 6.3.1-1. The minimum power is verified in beam locked mode with the test metric of EIRP (Link=TX beam peak direction, Meas=Link angle).

6.3D.2 Transmit OFF power for UL-MIMO

For UE supporting UL-MIMO, the transmit OFF power is defined as the TRP in the channel bandwidth when the transmitter is OFF. The transmitter is considered OFF when the UE is not allowed to transmit or during periods when the UE is not transmitting a sub-frame. During DTX and measurements gaps, the transmitter is not considered OFF. The minimum output power shall not exceed the values specified in Table 6.3.2-1. The requirement is verified with the test metric of TRP (Link=TX beam peak direction).

6.3D.3 Transmit ON/OFF time mask for UL-MIMO

For UE supporting UL-MIMO, the ON/OFF time mask requirements in subclause 6.3.3 apply. The requirements shall be met with the UL-MIMO configurations specified in Table 6.2D.1.3-3.

6.4 Transmit signal quality

6.4.1 Frequency Error

The UE modulated carrier frequency shall be accurate to within ±0.1 PPM observed over a period of 1 msec compared to the carrier frequency received from the NR gNB.

The frequency error is defined as a directional requirement. The requirement is verified in beam locked mode with the test metric of Frequency (Link=TX beam peak direction, Meas=Link angle).

6.4.2 Transmit modulation quality

Transmit modulation quality defines the modulation quality for expected in-channel RF transmissions from the UE. The transmit modulation quality is specified in terms of:

- Error Vector Magnitude (EVM) for the allocated resource blocks (RBs)
- EVM equalizer spectrum flatness derived from the equalizer coefficients generated by the EVM measurement process
- Carrier leakage
- In-band emissions for the non-allocated RB

All the parameters defined in subclause 6.4.2 are defined using the measurement methodology specified in TBD.

All the requirements in 6.4.2 are defined as directional requirement. The requirements are verified in beam locked mode on beam peak direction.

6.4.2.1 Error vector magnitude

The Error Vector Magnitude is a measure of the difference between the reference waveform and the measured waveform. This difference is called the error vector. Before calculating the EVM, the measured waveform is corrected by the sample timing offset and RF frequency offset. Then the carrier leakage shall be removed from the measured waveform before calculating the EVM.

The measured waveform is further equalised using the channel estimates subjected to the EVM equaliser spectrum flatness requirement specified in sub-clauses 6.4.2.4 and 6.4.2.5. For DFT-s-OFDM waveforms, the EVM result is defined after the front-end FFT and IDFT as the square root of the ratio of the mean error vector power to the mean reference power expressed as a %. For CP-OFDM waveforms, the EVM result is defined after the front-end FFT as the square root of the ratio of the mean error vector power to the mean reference power expressed as a %. The basic EVM measurement interval in the time domain is one preamble sequence for the PRACH and the duration of PUCCH/PUSCH channel, or one hop, if frequency hopping is enabled for PUCCH and PUSCH in the time domain. The EVM measurement interval is reduced by any symbols that contains an allowable power transient as defined in subclause 6.3.3.

The RMS average of the basic EVM measurements for the average EVM case, and for the reference signal EVM case, for the different modulations schemes shall not exceed the values specified in Table 6.4.2.1-1 for the parameters defined in Table 6.4.2.1-2 or Table 6.4.2.1-3 depending on UE power class. The measurement interval for the EVM determination is 10 subframes.. The requirement is verified with the test metric of EVM (Link=TX beam peak direction, Meas=Link angle).

Table 6.4.2.1-1: Minimum requirements for Error Vector Magnitude

Parameter	Unit	Average EVM Level	Reference Signal EVM Level
Pi/2 BPSK	%	30	30
QPSK	%	17.5	17.5
16 QAM	%	12.5	12.5
64 QAM	%	8	8

Table 6.4.2.1-2: Parameters for Error Vector Magnitude for power class 1

Parameter	Unit	Level
UE Output Power	dBm	≥ 4
UE output power for UL 16QAM	dBm	≥ 7
UE output power for UL 64QAM	dBm	≥ 11
Operating conditions		Normal conditions

Table 6.4.2.1-3: Parameters for Error Vector Magnitude for power class 2, 3, and 4

Parameter	Unit	Level
UE Output Power	dBm	≥ -13
UE output power for UL 16QAM	dBm	≥ -10
UE output power for UL 64QAM	dBm	≥ -6
Operating conditions		Normal conditions

6.4.2.2 Carrier leakage

6.4.2.3 In-band emissions

The in-band emission is defined as the average across 12 sub-carriers and as a function of the RB offset from the edge of the allocated UL transmission bandwidth. The in-band emission is measured as the ratio of the UE output power in a non–allocated RB to the UE output power in an allocated RB.

The basic in-band emissions measurement interval is identical to that of the EVM test.

The relative in-band emission shall not exceed the values specified in Table 6.4.2.3-1.

The requirement is verified with the test metric of In-band emission (Link=TX beam peak direction, Meas=Link angle).

Table 6.4.2.3-1: Requirements for in-band emissions

Parameter description	Unit	Limit (NOTE 1)		Applicable Frequencies
General	dB	$max\begin{bmatrix} -25 - 10.\log_{10}\left(\frac{N_{RB}}{L_{CRB}}\right), \\ 20.\log_{10}(EVM) - 5.\frac{(\lvert\Delta_{RB}\rvert - 1)}{L_{CRB}}, \\ -55.1dBm - P_{RB} \end{bmatrix}$		Any non-allocated (NOTE 2)
IQ Image	dB	-25	Output power > 10 dBm	Image frequencies (NOTES 2, 3)
		-20	Output power ≤ 10 dBm	
Carrier leakage	dBc	-25	Output power > 0 dBm	Carrier frequency (NOTES 4, 5)
		-20	-13 dBm ≤ Output power ≤ 0 dBm	

NOTE 1: An in-band emissions combined limit is evaluated in each non-allocated RB. For each such RB, the minimum requirement is calculated as the higher of (P_{RB} - 25 dB) and the power sum of all limit values (General, IQ Image or Carrier leakage) that apply. P_{RB} is defined in NOTE 10.

NOTE 2: The measurement bandwidth is 1 RB and the limit is expressed as a ratio of measured power in one non-allocated RB to the measured average power per allocated RB, where the averaging is done across all allocated RBs. For pi/2 BPSK with Spectrum Shaping, the limit is expressed as a ratio of measured power in one non-allocated RB to the measured power in the allocated RB with highest PSD

NOTE 3: The applicable frequencies for this limit are those that are enclosed in the reflection of the allocated bandwidth, based on symmetry with respect to the carrier frequency, but excluding any allocated RBs.

NOTE 4: The measurement bandwidth is 1 RB and the limit is expressed as a ratio of measured power in one non-allocated RB to the measured total power in all allocated RBs.

NOTE 5: The applicable frequencies for this limit are those that are enclosed in the RBs containing the DC frequency if N_{RB} is odd, or in the two RBs immediately adjacent to the DC frequency if N_{RB} is even,but excluding any allocated RB.

NOTE 6: L_{CRB} is the Transmission Bandwidth (see Figure 5.3.3-1).

NOTE 7: N_{RB} is the Transmission Bandwidth Configuration (see Figure 5.3.3-1).

NOTE 8: EVM s the limit for the modulation format used in the allocated RBs.

NOTE 9: Δ_{RB} is the starting frequency offset between the allocated RB and the measured non-allocated RB (e.g. Δ_{RB}= 1 or Δ_{RB}= -1 for the first adjacent RB outside of the allocated bandwidth).

NOTE 10: P_{RB} is the transmitted power per allocated RB, measured in dBm.

NOTE 11: All powers are EIRP in beam peak direction.

6.4.2.4 EVM equalizer spectrum flatness

The EVM measurement process (as described in TBD) entails generation of a zero-forcing equalizer. The EVM equalizer spectrum flatness is defined in terms of the maximum peak-to-peak ripple of the equalizer coefficients (dB) across the allocated uplink block. The basic measurement interval is the same as for EVM.

For BPSK modulation waveforms, the minimum requirements are defined in Clause 6.4.2.5.

The peak-to-peak variation of the EVM equalizer coefficients contained within the frequency range of the uplink allocation shall not exceed the maximum ripple specified in Table 6.4.2.4-1 for normal conditions. For uplink allocations contained within both Range 1 and Range 2, the coefficients evaluated within each of these frequency ranges shall meet the corresponding ripple requirement and the following additional requirements: the relative difference between the maximum coefficient in Range 1 and the minimum coefficient in Range 2 (Table 6.4.2.4-1) must not be larger than 7 dB, and the relative difference between the maximum coefficient in Range 2 and the minimum coefficient in Range 1 must not be larger than 8 dB (see Figure 6.4.2.4-1).

The requirement is verified with the test metric of EVM SF (Link=TX beam peak direction, Meas=Link angle).

Table 6.4.2.4-1: Minimum requirements for EVM equalizer spectrum flatness (normal conditions)

Frequency range	Maximum ripple (dB)
$F_{UL\_Meas} – F_{UL\_Low} \geq$ X MHz and $F_{UL\_High} – F_{UL\_Meas} \geq$ X MHz (Range 1)	6 (p-p)
$F_{UL\_Meas} – F_{UL\_Low} <$ X MHz or $F_{UL\_High} – F_{UL\_Meas} <$ X MHz (Range 2)	9 (p-p)
NOTE 1: F_{UL_Meas} refers to the sub-carrier frequency for which the equalizer coefficient is evaluated NOTE 2: F_{UL_Low} and F_{UL_High} refer to channel edges NOTE 3: X, in MHz, is equal to 20% of the CC bandwidth	

Table 6.4.2.4-2: (Void)

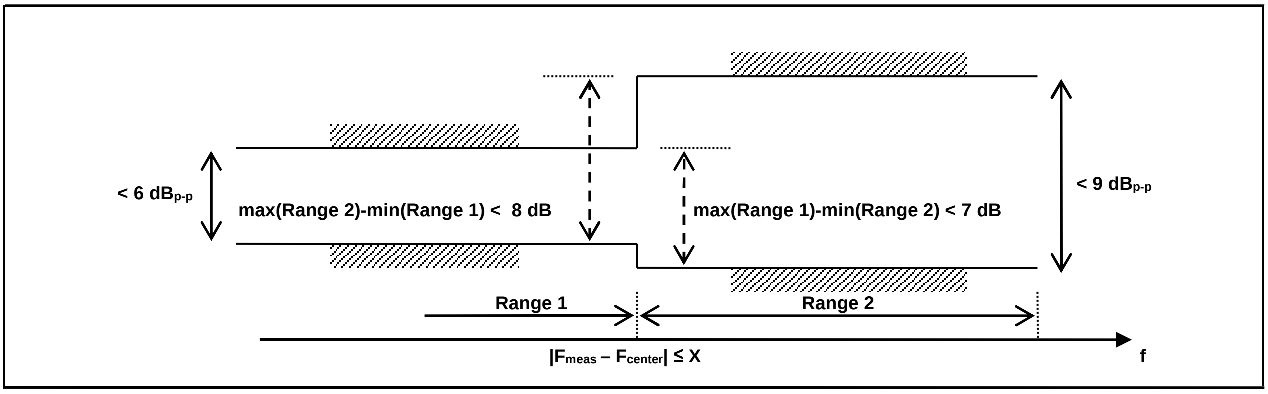

Figure 6.4.2.4-1: The limits for EVM equalizer spectral flatness with the maximum allowed variation of the coefficients indicated under normal conditions

6.4.2.5 EVM spectral flatness for pi/2 BPSK modulation with spectrum shaping

These requirements are defined for pi/2 BPSK modulation. The EVM equalizer coefficients across the allocated uplink block shall be modified to fit inside the mask specified in Table 6.4.2.5-1 for normal conditions, prior to the calculation of EVM.

Table 6.4.2.5-1: Mask for EVM equalizer coefficients for pi/2 BPSK with spectrum shaping, normal conditions

Frequency range	Parameter	Maximum ripple (dB)
F_meas – F_center ≤ X MHz or F_center – F_meas ≤ X MHz (Range 1)	X1	6 (p-p)
F_meas – F_center > X MHz or F_center – F_meas < X MHz (Range 2)	X2	14 (p-p)
NOTE 1: F_meas refers to the sub-carrier frequency for which the equalizer coefficient is evaluated NOTE 2: F_center refers to the center frequency of an allocated block of PRBs NOTE 3: X, in MHz, is equal to 25% of the bandwidth of the PRB allocation NOTE 4: See Figure 6.4.2.5-1 for description of X1, X2 and X3		

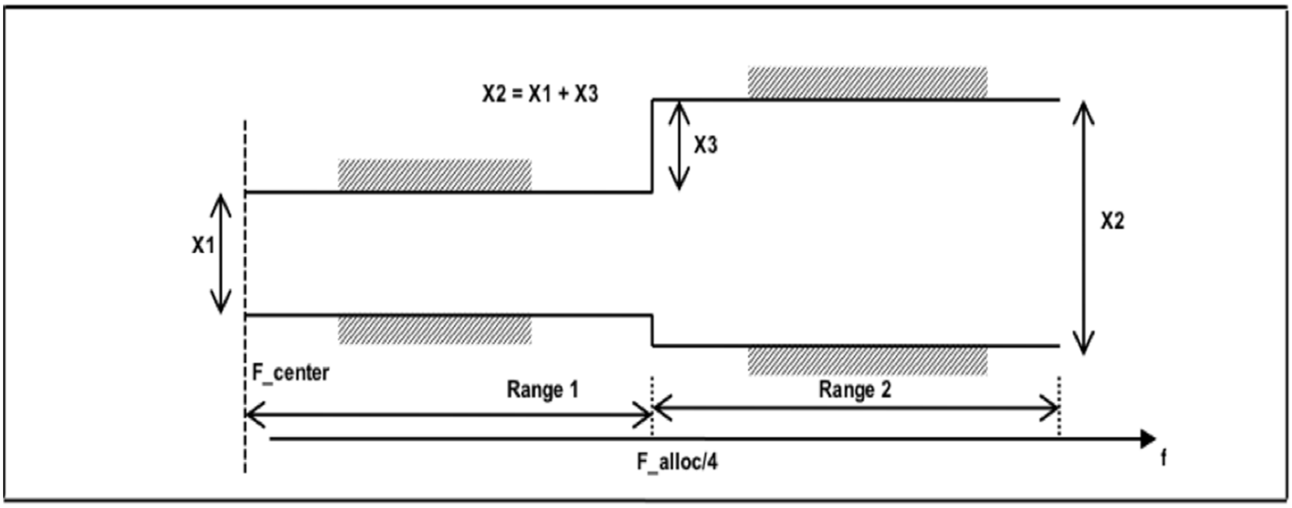

Figure 6.4.2.5-1: The limits for EVM equalizer spectral flatness with the maximum allowed variation. F_center denotes the center frequency of the allocated block of PRBs. F_alloc denotes the bandwidth of the PRB allocation.

UE shaping filter requirement for pi/2 BPSK: This requirement does not apply to other modulation types. The UE shall be allowed to employ spectral shaping for pi/2 BPSK and the shaping filter shall be restricted so that the impulse response of the transmit chain shall meet

$$|\tilde{a}_t(\tau,0)| \geq |\tilde{a}_t(t,\tau)| \quad \forall\tau \neq 0$$

$$20log_{10}|\tilde{a}_t(t,\tau)| < -15 \text{ dB} \quad 1< \tau < M - 1,$$

Where, $|\tilde{a}_t(\tau,0)| = IDFT\{|\tilde{a}_t(t,f)|\, e^{j\varphi(t,f)}\}$, f is the frequency of the M allocated subcarriers, $\tilde{a}(t,f)$ and $\varphi(t,f)$ are ã the amplitude and phase response, respectively of the transmit chain.

6.4A Transmit signal quality for CA

6.4A.1 Frequency error for CA

6.4A.2 Transmit modulation quality

6.4A.2.1 Error Vector magnitude

6.4A.2.2 Carrier leakage for CA

For intra-band contiguous CA with UL and DL configured for same component carriers, carrier leakage is an additive sinusoid waveform that is confined within the aggregated transmission bandwidth configuration. The carrier leakage requirement is defined for each component carrier and is measured on the component carrier with PRBs allocated. The measurement interval is one slot in the time domain.

For intra-band contiguous CA with different component carriers configured for UL than for DL, carrier leakage is an additive sinusoid waveform that is confined within aggregated receiver bandwidth configuration. The carrier leakage requirement is defined for each component carrier and is measured on the component carrier with PRBs allocated. The measurement interval is one slot in the time domain.

For intra-band non-contiguous CA, carrier leakage is an additive sinusoid waveform that is confined within outer edges of the aggregated receiver bandwidth configuration. The carrier leakage requirement is defined for each component carrier and is measured on the component carrier with PRBs allocated. The measurement interval is one slot in the time domain.

Note: For intra-band non-contiguous CA, carrier leakage may land outside component carrier bandwidth.

The relative carrier leakage power is a power ratio of the additive sinusoid waveform and the modulated waveform. The relative carrier leakage power shall not exceed the values specified in Table 6.4.2.2A-1. The requirement is verified with the test metric of Carrier Leakage (Link=TX beam peak direction, Meas=Link angle).

Table 6.4A.2.2-1: Minimum requirements for Relative Carrier Leakage Power

Parameters	Relative Limit (dBc)
Output power >TBD dBm	-25
-TBD dBm ≤ Output power ≤ TBD dBm	-20
-TDB dBm ≤ Output power < -TBD dBm	-10

6.4A.2.3 Inband emissions

IQ Image for DL CA is specified in relation to DL carrier frequency. IQ Image is specified in Table 6.4A.2.3-1. The requirement is verified with the test metric of In-band emission (Link=TX beam peak direction, Meas=Link angle).

Table 6.4A.2.3-1: Requirements for IQ Image

Parameter description	Unit	Limit (NOTE 1)		Applicable Frequencies
IQ Image	dB	-25	Output power > 10 dBm	Image frequencies
		-20	Output power ≤ 10 dBm	
NOTE 1: The measurement bandwidth is 1 RB and the limit is expressed as a ratio of measured power to the measured average power per allocated RB, where the averaging is done across all allocated RBs. For pulse-shaped pi/2 BPSK, the limit is expressed as a ratio of measured power in one non-allocated RB to the measured power in the allocated RB with highest PSD NOTE 2: The measurement bandwidth is 1 RB and the limit is expressed as a ratio of measured power in one non-allocated RB to the measured total power in all allocated RBs. NOTE 3: All powers are EIRP in beam peak direction.				

6.4A.2.4 EVM equalizer spectrum flatness

6.4D Transmit signal quality for UL-MIMO

For UE(s) supporting UL-MIMO, the transmit modulation quality requirements in subclause 6.4 apply. The requirements shall be met with the UL-MIMO configurations specified in Table 6.2D.1.3-3. Each polarization could be verified separately in accordance with the test procedure specified in TS 38.521-2.

6.5 Output RF spectrum emissions

6.5.1 Occupied bandwidth

Occupied bandwidth is defined as the bandwidth containing 99 % of the total integrated mean power of the transmitted spectrum on the assigned channel. The occupied bandwidth for all transmission bandwidth configurations (Resources Blocks) shall be less than the channel bandwidth specified in Table 6.6.1-1.

The occupied bandwidth is defined as a directional requirement. The requirement is verified in beam locked mode with the test metric of OBW (Link=TX beam peak direction, Meas=Link angle).

Table 6.6.1-1: Occupied channel bandwidth

	Occupied channel bandwidth / Channel bandwidth			
	50 MHz	**100 MHz**	**200 MHz**	**400 MHz**
Channel bandwidth (MHz)	50	100	200	400

6.5.2 Out of band emissions

The Out of band emissions are unwanted emissions immediately outside the assigned channel bandwidth resulting from the modulation process and non-linearity in the transmitter but excluding spurious emissions. This out of band emission limit is specified in terms of a spectrum emission mask and an adjacent channel leakage power ratio. Additional requirements to protect specific bands are also considered.

All out of band emissions for frequency range 2 are TRP.

6.5.2.1 Spectrum emission mask

The spectrum emission mask of the UE applies to frequencies (Δf_{OOB}) starting from the ± edge of the assigned NR channel bandwidth. For frequencies greater than (Δf_{OOB}) as specified in Table 6.5.2.1-1 the spurious requirements in subclause 6.5.3 are applicable. If for some frequency the carrier leakage overlaps with spectrum emission mask, then the emission mask does not apply for that frequency.

The power of any UE emission shall not exceed the levels specified in Table 6.5.2.1-1 for the specified channel bandwidth. The requirement is verified in beam locked mode with the test metric of TRP (Link=TX beam peak direction).

Table 6.5.2.1-1: General NR spectrum emission mask for frequency range 2.

Spectrum emission limit (dBm)/ Channel bandwidth					
Δf_{OOB} (MHz)	**50 MHz**	**100 MHz**	**200 MHz**	**400 MHz**	**Measurement bandwidth**
± 0-5	-5	-5	-5	-5	1 MHz
± 5-10	-13	-5	-5	-5	1 MHz
± 10-20	-13	-13	-5	-5	1 MHz
± 20-40	-13	-13	-13	-5	1 MHz
± 40-100	-13	-13	-13	-13	1 MHz
± 100-200		-13	-13	-13	1 MHz
± 200-400			-13	-13	1 MHz
± 400-800				-13	1 MHz
NOTE 1: If carrier leakage lands inside the spectrum emission region, exception to the general limit applies. For carrier leakage the requirements specified in section 6.4A.2.2 shall apply.					

6.5.2.2 Additional spectrum emissions mask

Detailed structure of the subclause is TBD.

6.5.2.3 Adjacent channel leakage ratio

Adjacent Channel Leakage power Ratio (ACLR) is the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency. ACLR requirement is specified for a scenario in which adjacent carrier is another NR channel.

NR Adjacent Channel Leakage power Ratio (NR_{ACLR}) is the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency at nominal channel spacing. The assigned NR channel power and adjacent NR channel power are measured with rectangular filters with measurement bandwidths specified in Table 6.5.2.3-1.

If the measured adjacent channel power is greater than –35 dBm then the NR_{ACLR} shall be higher than the value specified in Table 6.5.2.3-1. The requirement is verified in beam locked mode with the test metric of TRP (Link=TX beam peak direction).

Table 6.5.2.3-1: General requirements for NR_{ACLR}

	Channel bandwidth / NR_{ACLR} / Measurement bandwidth			
	50 MHz	**100 MHz**	**200 MHz**	**400 MHz**
NR_{ACLR} for band n257, n258, n261	17 dB	17 dB	17 dB	17 dB
NR_{ACLR} for band n260	16 dB	16 dB	16 dB	16 dB
NR channel measurement bandwidth	47.52 MHz	95.04 MHz	190.08 MHz	380.16 MHz
Adjacent channel centre frequency offset (MHz)	+50 / -50	+100.0 / -100.0	+200 / -200	+400 / -400

6.5.3 Spurious emissions

Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emissions, intermodulation products and frequency conversion products, but exclude out of band emissions unless otherwise stated. The spurious emission limits are specified in terms of general requirements in line with SM.329 [7] and NR operating band requirement to address UE co-existence. Spurious emissions are measured as TRP.

To improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

Unless otherwise stated, the spurious emission limits apply for the frequency ranges that are more than F_{OOB} (MHz) in Table 6.5.3-1 starting from the edge of the assigned NR channel bandwidth. The spurious emission limits in Table 6.5.3-2 apply for all transmitter band configurations (NRB) and channel bandwidths. The requirement is verified in beam locked mode with the test metric of TRP (Link=TX beam peak direction).

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

Table 6.5.3-1: Boundary between NR out of band and spurious emission domain

Channel bandwidth	50 MHz	100 MHz	200 MHz	400 MHz
OOB boundary F_{OOB} (MHz)	100	200	400	800

Table 6.5.3-2: Spurious emissions limits

Frequency Range	Maximum Level	Measurement bandwidth	NOTE
30 MHz ≤ f < 1000 MHz	-36 dBm	100 kHz	
1 GHz ≤ f < 12.75 GHz	-30 dBm	1 MHz	
12.75 GHz ≤ f < 2nd harmonic of the upper frequency edge of the UL operating band in GHz	-13 dBm	1 MHz	

6.5.3.1 Spurious emission band UE co-existence

This clause specifies the requirements for the specified NR band, for coexistence with protected bands.

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

Table 6.6.3.2-1: Requirements

NR Band	Spurious emission						
	Protected band/frequency range	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	NOTE
n257	NR Band n260	F_{DL_low}	-	F_{DL_high}	-2	100	
	Frequency range	23600	-	24000	TBD	200	
	Frequency range	57000	-	66000	2	100	
n258	Frequency range	23600	-	24000	TBD	200	
	Frequency range	57000	-	66000	2	100	
n260	NR Band 257	F_{DL_low}	-	F_{DL_high}	-5	100	
	NR Band 261	F_{DL_low}	-	F_{DL_high}	-5	100	
	Frequency range	23600	-	24000	TBD	200	
	Frequency range	57000	-	66000	2	100	
n261	NR Band 260	F_{DL_low}	-	F_{DL_high}	-2	100	
	Frequency range	23600	-	24000	TBD	200	
	Frequency range	57000	-	66000	2	100	
NOTE 1: F_{DL_low} and F_{DL_high} refer to each NR frequency band specified in Table 5.2-1 NOTE 2: The protection of frequency range 23600-2400MHz is meant for protection of satellite passive services.							

6.5A Output RF spectrum emissions for CA

6.5A.1 Occupied bandwidth for CA

For intra-band contiguous carrier aggregation, the occupied bandwidth is a measure of the bandwidth containing 99 % of the total integrated power of the transmitted spectrum. The occupied bandwidth for CA shall be less than the aggregated channel bandwidth defined in subclause 5.5A.

The occupied bandwidth for CA is defined as a directional requirement. The requirement is verified in beam locked mode on beam peak direction.

6.5A.2 Out of band emissions

6.5A.2.1 Spectrum emission mask for CA

For inter-band carrier aggregation with one component carrier per operating band and the uplink active in two NR bands, the spectrum emission mask of the UE is defined per component carrier while both component carriers are active, and the requirements are specified in subclauses 6.5.2.1. If for some frequency spectrum emission masks of component carriers overlap, then spectrum emission mask allowing higher power spectral density applies for that frequency. If for some frequency a component carrier spectrum emission mask overlaps with the channel bandwidth of another component carrier, then the emission mask does not apply for that frequency.

For intra-band contiguous carrier aggregation, the spectrum emission mask of the UE applies to frequencies (Δf_{OOB}) starting from the ± edge of the aggregated channel bandwidth (Table 5.3A.5-1) For any bandwidth class defined in Table 5.3A.5-1, the UE emission shall not exceed the levels specified in Table 6.5A.2.1-1. The requirement is verified in beam locked mode with the test metric of TRP (Link=TX beam peak direction).

Table 6.5A.2.1-1: General NR spectrum emission mask for intra-band contiguous CA in frequency range 2

Δf_{OOB} (MHz)	Any carrier aggregation bandwidth class	Measurement bandwidth
± 0-0.1*$BW_{Channel\_CA}$	-5	1 MHz
± 0.1*$BW_{Channel\_CA}$ - 2*$BW_{Channel\_CA}$	-13	1 MHz
NOTE 1: If carrier leakage lands inside the spectrum emission region, exception to the general limit applies. For carrier leakage the requirements specified in section 6.4A.2.2 shall apply.		

For intra-band non-contiguous carrier aggregation transmission, the spectrum emission mask requirement is defined as a composite spectrum emissions mask. Composite spectrum emission mask applies to frequencies up to ± Δf_{OOB} starting from the edges of the sub-blocks. Composite spectrum emission mask is defined as follows

a) Composite spectrum emission mask is a combination of individual sub-block spectrum emissions masks

b) In case the sub-block consists of one component carrier the sub-lock general spectrum emission mask is defined in subclause 6.5.2.1

c) If for some frequency sub-block spectrum emission masks overlap then spectrum emission mask allowing higher power spectral density applies for that frequency

d) If for some frequency a sub-block spectrum emission mask overlaps with the sub-block bandwidth of another sub-block, then the emission mask does not apply for that frequency.

For combinations of intra-band and inter-band carrier aggregation with three uplink component carriers (up to two contiguously aggregated carriers per band), the spectrum emission mask of the UE is defined per NR band while all component carriers are active. For the NR band supporting one component carrier the requirements in subclauses 6.6.2.1 applies. For the NR band supporting two contiguous component carriers the requirements specified in subclause 6.6A.2.1 apply. If for some frequency spectrum emission masks of single component carrier and two contiguous component carriers overlap, then spectrum emission mask allowing higher power spectral density applies for that frequency. If for some frequency spectrum emission masks of single component carrier or two contiguous component carriers overlap, then the emission mask does not apply for that frequency.

For any CA operating mode (inter-band and intra-band), if for some frequency the carrier leakage overlaps with spectrum emission mask then the emission mask does not apply for that frequency.

6.5A.2.3 Adjacent channel leakage ratio for CA

For intra-band contiguous carrier aggregation, the carrier aggregation NR adjacent channel leakage power ratio (CA NR_{ACLR}) is the ratio of the filtered mean power centred on the aggregated channel bandwidth to the filtered mean power centred on an adjacent aggregated channel bandwidth at nominal channel spacing. The assigned aggregated channel bandwidth power and adjacent aggregated channel bandwidth power are measured with rectangular filters with measurement bandwidths specified in 6.5A.2.3-1. If the measured adjacent channel power is greater than -35 dBm then the NR_{ACLR} shall be higher than the value specified in Table 6.5A.2.3-1.

Table 6.5A.2.3-1: General requirements for CA NR_{ACLR}

	CA bandwidth class / CA NR_{ACLR} / Measurement bandwidth
	Any CA bandwidth class
CA NR_{ACLR} for band n257, n258, n261	17 dB
CA NR_{ACLR} for band n260	16 dB
NR channel measurement bandwidth	$BW_{Channel\_CA}$ * 0.9504

6.5D Output RF spectrum emissions for UL-MIMO

6.5D.1 Occupied bandwidth for UL-MIMO

For UE(s) supporting UL-MIMO, the occupied bandwidth requirement in subclause 6.5.1 apply. The requirements shall be met with the UL-MIMO configurations specified in Table 6.2D.1.3-3.

6.5D.2 Out of band emissions for UL-MIMO

For UE(s) supporting UL-MIMO, the out of band emissions requirements in subclause 6.5.2 apply. The requirements shall be met with the UL-MIMO configurations specified in Table 6.2D.1.3-3.

6.5D.3 Spurious emissions for UL-MIMO

For UE(s) supporting UL-MIMO, the spurious emissions requirements in subclause 6.5.3 apply. The requirements shall be met with the UL-MIMO configurations specified in Table 6.2D.1.3-3.

7 Receiver characteristics

7.1 General

Unless otherwise stated, the receiver characteristics are specified over the air (OTA).

7.2 Diversity characteristics

The minimum requirements on effective isotropic sensitivity (EIS) are defined with two orthogonal polarizations.

7.3 Reference sensitivity

7.3.1 General

The reference sensitivity power level REFSENS is the EIS level (total component) at the centre of the quiet zone in the RX beam peak direction, at which the throughput shall meet or exceed the requirements for the specified reference measurement channel.

7.3.2 Reference sensitivity power level

7.3.2.1 Reference sensitivity power level for power class 1

The throughput shall be ≥ 95 % of the maximum throughput of the reference measurement channels as specified in Annex A] (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal) with peak reference sensitivity specified in Table 7.3.2.1-1. The requirement is verified with the test metric of EIS (Link=Beam peak search grids, Meas=Link Angle).

Table 7.3.2.1-1: Reference sensitivity for power class 1

Operating band	REFSENS (dBm) / Channel bandwidth			
	50 MHz	100 MHz	200 MHz	400 MHz
n257	-97.51	-94.51	-91.51	-88.51
n258	-97.51	-94.51	-91.51	-88.51
n260	-94.51	-91.51	-88.51	-91.51
n261	-97.51	-94.51	-91.51	-88.51

7.3.2.2 Reference sensitivity power level for power class 2

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annex A (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal) with peak reference sensitivity specified in Table 7.3.2.2-1. The requirement is verified with the test metric of EIS (Link=Beam peak search grids, Meas=Link Angle).

Table 7.3.2.2-1: Reference sensitivity for power class 2

Operating band	REFSENS (dBm) / Channel bandwidth			
	50 MHz	100 MHz	200 MHz	400 MHz
n257	-94.5	-91.5	-88.5	-85.5
n258	-94.5	-91.5	-88.5	-85.5
n260				
n261	-94.5	-91.5	-88.5	-85.5

7.3.2.3 Reference sensitivity power level for power class 3

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annex A (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal) with peak reference sensitivity specified in Table 7.3.2.3-1. The requirement is verified with the test metric of EIS (Link=Beam peak search grids, Meas=Link Angle).

Table 7.3.2.3-1: Reference sensitivity

Operating band	REFSENS (dBm) / Channel bandwidth			
	50 MHz	100 MHz	200 MHz	400 MHz
n257	-88.3	-85.3	-82.3	-79.3
n258	-88.3	-85.3	-82.3	-79.3
n260	-85.7	-82.7	-79.7	-76.7
n261	-88.3	-85.3	-82.3	-79.3

7.3.2.4 Reference sensitivity power level for power class 4

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annex A (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal) with peak reference sensitivity specified in Table 7.3.2.4-1. The requirement is verified with the test metric of EIS (Link=Beam peak search grids, Meas=Link Angle).

Table 7.3.2.4-1: Reference sensitivity for power class 4

Operating band	REFSENS (dBm) / Channel bandwidth			
	50 MHz	100 MHz	200 MHz	400 MHz
n257	-97	-94	-91	-88
n258	-97	-94	-91	-88
n260	-95	-92	-89	-86
n261	-97	-94	-91	-88

7.3A Reference sensitivity for CA

7.3A.1 General

7.3A.2 Reference sensitivity power level for CA

7.3A.2.1 Intra-band contiguous CA

For intra-band contiguous and non-contiguous carrier aggregation the throughput in QPSK R=1/3 of each component carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annex A (with one sided dynamic OCNG Pattern OP.1 TDD for the DL-signal) with peak reference sensitivity degradation, relative to values determined from section 7.3.2, as specified in Table 7.3A.2.1-1.

Table 7.3A.2.1-1: ΔR_{IB} EIS Relaxation for CA operation by aggregated channel bandwidth

Aggregated Channel BW '$BW_{Channel\_CA}$' (MHz)	ΔR_{IB} (dB)
$BW_{Channel\_CA} \leq 800$	0.0
$800 < BW_{Channel\_CA} \leq 1200$	0.5

7.3D Reference sensitivity for UL-MIMO

For UL-MIMO, the reference sensitivity requirements in subclause 7.3 apply. The requirements shall be met with the UL-MIMO configurations specified in Table 6.2D.1.3-3.

7.4 Maximum input level

The maximum input level is defined as the maximum mean power received at the UE RIB, at which the specified relative throughput shall meet or exceed the minimum requirements for the specified reference measurement channel.

The maximum input level is defined as a directional requirement. The requirement is verified in beam locked mode in the direction where peak gain is achieved.

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.X.X, (with one sided dynamic OCNG Pattern as described in Annex XXX) with parameters specified in Table XXXX. The requirement is verified with the test metric of EIS (Link=RX beam peak direction, Meas=Link angle).

Table 7.4-1: Maximum input level

Rx Parameter	Units	Channel bandwidth			
		50 MHz	100 MHz	200 MHz	400 MHz
Power in transmission bandwidth configuration	dBm	-25 (NOTE 2)			
NOTE 1: The transmitter shall be set to 4dB below P_{CMAX_L} at the minimum uplink configuration specified in Table 7.3.X-X with P_{CMAX_L} as defined in subclause X.X.X. NOTE 2: Reference measurement channel is specified in Annex A.3.2: QPSK, R=1/3 variant with one sided dynamic OCNG Pattern as described in Annex A.					

7.4A Maximum input level for CA

For carrier aggregation maximum input level is defined as the exact wording TBD, over the aggregated receiver bandwidth, at which the specified relative throughput shall meet or exceed the minimum requirements for the specified reference measurement channel over each component carrier. The minimum requirement is the same as the one specified in Table 7.4-1. The requirement is verified with the test metric of EIS (Link=RX beam peak direction, Meas=Link angle).

7.4D Maximum input level for UL-MIMO

For UL-MIMO, the maximum input level requirements in subclause 7.4 apply. The requirements shall be met with the UL-MIMO configurations specified in Table 6.2D.1.3-3.

7.5 Adjacent channel selectivity

Adjacent Channel Selectivity (ACS) is a measure of a receiver's ability to receive a NR signal at its assigned channel frequency in the presence of an adjacent channel signal at a given frequency offset from the centre frequency of the assigned channel. ACS is the ratio of the receive filter attenuation on the assigned channel frequency to the receive filter attenuation on the adjacent channel(s).

The requirement applies at the RIB when the AoA of the incident wave of the wanted signal and the interfering signal are both from the direction where peak gain is achieved.

The wanted and interfering signals apply to all supported polarizations, under the assumption of polarization match.

The UE shall fulfil the minimum requirement specified in Table 7.5-1 for all values of an adjacent channel interferer up to –25 dBm. However it is not possible to directly measure the ACS, instead the lower and upper range of test parameters are chosen in Table 7.5-2 and Table 7.5-3 where the throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.3.2, with QPSK, R=1/3 and one sided dynamic OCNG Pattern for the DL-signal as described in Annex A. The requirement is verified with the test metric of EIS (Link=RX beam peak direction, Meas=Link angle).

Table 7.5-1: Adjacent channel selectivity

		Adjacent channel selectivity / Channel bandwidth			
Operating band	Units	50 MHz	100 MHz	200 MHz	400 MHz
n257, n258, n261	dB	23	23	23	23
n260	dB	22	22	22	22

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

Rx Parameter	Units	Channel bandwidth			
		50 MHz	100 MHz	200 MHz	400 MHz
Power in Transmission Bandwidth Configuration	dBm	REFSENS + 14 dB			
$P_{Interferer}$ for band n257, n258, n261	dBm	REFSENS + 35.5 dB	REFSENS +35.5dB	REFSENS +35.5dB	REFSENS +35.5dB
$P_{Interferer}$ for band n260	dBm	REFSENS + 34.5 dB	REFSENS +34.5dB	REFSENS +34.5dB	REFSENS +34.5dB
$BW_{Interferer}$	MHz	50	100	200	400
$F_{Interferer}$ (offset)	MHz	50 / -50 NOTE 3	100 / -100 NOTE 3	200 / -200 NOTE 3	400 / -400 NOTE 3
NOTE 1: The interferer consists of the Reference measurement channel specified in Annex A.3.2 with one sided dynamic OCNG Pattern as described in Annex A.3.2 and set-up according to Annex C. NOTE 2: The REFSENS power level is specified in Section 7.3.2, which are applicable to different UE power classes. NOTE 3: The absolute value of the interferer offset $F_{Interferer}$ (offset) shall be further adjusted to ([│$F_{Interferer}$│/SCS] + 0.5)SCS($\lceil \lvert F_{Interferer} \rvert / SCS \rceil + 0.5)SCS$ MHz with SCS the sub-carrier spacing of the wanted signal in MHz. Wanted and interferer signal have same SCS.					

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

Rx Parameter	Units	Channel bandwidth			
		50 MHz	100 MHz	200 MHz	400 MHz
Power in Transmission Bandwidth Configuration for band n257, n258, n261	dBm	-46.5	-46.5	-46.5	-46.5
Power in Transmission Bandwidth Configuration for band n260	dBm	-45.5	-45.5	-45.5	-45.5
$P_{Interferer}$	dBm	-25			
$BW_{Interferer}$	MHz	50	100	200	400
$F_{Interferer}$ (offset)	MHz	50 / -50 NOTE 2	100 / -100 NOTE 2	200 / -200 NOTE 2	400 / -400 NOTE 2
NOTE 1: The interferer consists of the Reference measurement channel specified in Annex 3.2 with one sided dynamic OCNG Pattern TDD as described in Annex A and set-up according to Annex C. NOTE 2: The absolute value of the interferer offset $F_{Interferer}$ (offset) shall be further adjusted to ([│$F_{Interferer}$│/SCS] + 0.5)SCS ($\lceil \lvert F_{Interferer} \rvert / SCS \rceil + 0.5)SCS$ MHz with SCS the sub-carrier spacing of the wanted signal in MHz. Wanted and interferer signal have same SCS.					

7.5A Adjacent channel selectivity for CA

$\Delta f_{ACS}\Delta f_{ACS}$For intra-band contiguous carrier aggregation, the SCC(s) shall be configured at nominal channel spacing tothe PCC. The UE shall fulfil the minimum requirement specified in Table 7.5.1A-1 for an adjacent channel interferer on either side of the aggregated downlink signal at a specified frequency offset and for an interferer power up to -25 dBm.

The throughput of each carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.3.2 with one sided dynamic OCNG Pattern for the DL-signal as described in Annex A. The requirement is verified with the test metric of EIS (Link=RX beam peak direction, Meas=Link angle).

Table 7.5A-1: Adjacent channel selectivity for CA

Operating band	Units	Adjacent channel selectivity / CA bandwidth class
		All CA bandwidth class
n257, n258, n261	dB	23
n260	dB	22

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

Rx Parameter	Units	CA Bandwidth Class
		All CA bandwidth Classes
Pw in Transmission Bandwidth Configuration, per CC		REFSENS + 14 dB
$P_{Interferer}$ for band n257, n258, n261	dBm	Aggregated power + 21.5
$P_{Interferer}$ for band n260	dBm	Aggregated power + 20.5
$BW_{Interferer}$	MHz	$BW_{Channel\_CA}$
$F_{Interferer}$ (offset)	MHz	$BW_{Channel\_CA}$ NOTE 3
NOTE 1: The interferer consists of the Reference measurement channel specified in Annex 3.2 with one sided dynamic OCNG Pattern as described in Annex A and set-up according to Annex C. NOTE 2: The $F_{Interferer}$ (offset) is the frequency separation between the center of the aggregated CA bandwidth and the center frequency of the Interferer signal NOTE 3: The absolute value of the interferer offset $F_{Interferer}$ (offset) shall be further adjusted to ([│$F_{Interferer}$│/SCS] + 0.5)SCS $(\lceil \lvert F_{Interferer} \rvert / SCS \rceil + 0.5)SCS$ MHz with SCS the sub-carrier spacing of the wanted signal in MHz. Wanted and interferer signal have same SCS.		

Table 7.5A-3: Adjacent channel selectivity test parameters for CA, Case 2

Rx Parameter	Units	CA bandwidth class
		All CA bandwidth classes
Pw in Transmission Bandwidth Configuration, aggregated power for band n257, n258, n261	dBm	- 46.5
Pw in Transmission Bandwidth Configuration, aggregated power for band n260	dBm	-45.5
$P_{interferer}$	dBm	-25
$BW_{Interferer}$	MHz	$BW_{Channel\_CA}$
$F_{Interferer}$ (offset)	MHz	$BW_{Channel\_CA}$ NOTE 3
NOTE 1: The interferer consists of the Reference measurement channel specified in Annex 3.2 with one sided dynamic OCNG Pattern as described in Annex A and set-up according to Annex C. NOTE 2: The $F_{Interferer}$ (offset) is the frequency separation between the center of the aggregated CA bandwidth and the center frequency of the Interferer signal NOTE 3: The absolute value of the interferer offset $F_{Interferer}$ (offset) shall be further adjusted to ([│$F_{Interferer}$│/SCS] + 0.5)SCS $(\lceil \lvert F_{Interferer} \rvert / SCS \rceil + 0.5)SCS$ MHz with SCS the sub-carrier spacing of the wanted signal in MHz. Wanted and interferer signal have same SCS.		

For intra-band non-contiguous carrier aggregation with two component carriers, two different requirements apply for out-of-gap and in-gap. For out-of-gap, the UE shall meet the requirements for each component carrier as specified in subclauses 7.5. For in-gap, the requirement applies if the following minimum gap condition is met:

$$\Delta f_{ACS} \geq BW_1/2 + BW_2/2 + \max(BW_1, BW_2),$$

where Δf_{ACS} is the frequency separation between the center frequencies of the component carriers and $BW_k/2$ are the channel bandwidths of carrier k, k = 1,2.

If the minimum gap condition is met, the UE shall meet the requirements specified in subclauses 7.5 for each component carrier considered. The respective channel bandwidth of the component carrier under test will be used in the parameter calculations of the requirement. In case of more than two component carriers, the minimum gap condition is computed for any pair of adjacent component carriers following the same approach as the two component carriers. The in-gap requirement for the corresponding pairs shall apply if the minimum gap condition is met.

For every component carrier to which the requirements apply, the UE shall meet the requirement with one active interferer signal (in-gap or out-of-gap) while all downlink carriers are active.

7.5D Adjacent channel selectivity for UL-MIMO

For UL-MIMO, the adjacent channel selectivity requirements in subclause 7.5 apply. The requirements shall be met with the UL-MIMO configurations specified in Table 6.2D.1.3-3.

7.6 Blocking characteristics

7.6.1 General

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

The requirement applies at the RIB when the AoA of the incident wave of the wanted signal and the interfering signal are both from the direction where peak gain is achieved.

The wanted and interfering signals apply to all supported polarizations, under the assumption of polarization match.

7.6.2 In-band blocking

In-band blocking is defined for an unwanted interfering signal falling into the UE receive band or into the spectrum equivalent to twice the channel bandwidth below or above the UE receive band at which the relative throughput shall meet or exceed the minimum requirement for the specified measurement channels.

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annex A with one sided dynamic OCNG Pattern for the DL-signal as described in Annex A.The requirement is verified with the test metric of EIS (Link=RX beam peak direction, Meas=Link angle).

Table 7.6.2-1: In band blocking requirements

Rx parameter	Units	Channel bandwidth			
		50 MHz	**100 MHz**	**200 MHz**	**400 MHz**
Power in Transmission Bandwidth Configuration	dBm	REFSENS + 14dB			
$BW_{Interferer}$	MHz	50	100	200	400
$P_{Interferer}$ for bands n257, n258, n261	dBm	REFSENS + 35.5 dB	REFSENS + 35.5 dB	REFSENS + 35.5 dB	REFSENS + 35.5 dB
$P_{Interferer}$ for band n260	dBm	REFSENS + 34.5 dB	REFSENS + 34.5 dB	REFSENS + 34.5 dB	REFSENS + 34.5 dB
$F_{Ioffset}$	MHz	≤ 100 & ≥ -100 NOTE 5	≤ 200 & ≥ -200 NOTE 5	≤ 400 & ≥ -400 NOTE 5	≤ 800 & ≥ -800 NOTE 5
$F_{Interferer}$	MHz	F_{DL_low} + 25 to F_{DL_high} - 25	F_{DL_low} + 50 to F_{DL_high} - 50	F_{DL_low} + 100 to F_{DL_high} - 100	F_{DL_low} + 200 to F_{DL_high} - 200

NOTE 1: The interferer consists of the Reference measurement channel specified in Annex A.3.2 with one sided dynamic OCNG Pattern as described in Annex A and set-up according to Annex C.

NOTE2: The REFSENS power level is specified in Section 7.3.2, which are applicable according to different UE power classes.

NOTE 3: The wanted signal consists of the reference measurement channel specified in Annex A.3.2 QPSK, R=1/3 with one sided dynamic OCNG pattern as described in Annex A and set-up according to Annex C.

NOTE 4: $F_{Ioffset}$ is the frequency separation between the center of the aggregated CA bandwidth and the center frequency of the Interferer signal.

NOTE 5: The absolute value of the interferer offset $F_{Ioffset}$ shall be further adjusted to ([| $F_{Interferer}$ | /SCS] + 0.5)SCS$(\lceil |F_{Interferer}|/SCS \rceil + 0.5)SCS$ MHz with SCS the sub-carrier spacing of the wanted signal in MHz. Wanted and interferer signal have same SCS.

NOTE 6: $F_{Interferer}$ range values for unwanted modulated interfering signals are interferer center frequencies.

7.6.3 Out-of-band blocking

Detailed content of the subclause is TBD.

7.6A Blocking characteristics for CA

7.6A.1 General

7.6A.2 In-band blocking

For intra-band contiguous carrier aggregation, the SCC(s) shall be configured at nominal channel spacing to the PCC. The UE shall fulfil the minimum requirement specified in Table 7.6A.2-1 for an adjacent channel interferer on either side of the aggregated downlink signal at a specified frequency offset and for an interferer power up to -25 dBm. The throughput of each carrier shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.3.2 with one sided dynamic OCNG Pattern for the DL-signal as described in Annex A. The requirement is verified with the test metric of EIS (Link=RX beam peak direction, Meas=Link angle).

Table 7.6A.2-1: In band blocking minimum requirements for intra-band contiguous CA

Rx Parameter	Units	CA bandwidth class
		All CA bandwidth classes
Power in Transmission Bandwidth Configuration, per CC		REFSENS + 14 dB
Pinterferer for band n257, n258, n261	dBm	Aggregated power + 21.5
Pinterferer for band n260	dBm	Aggregated power + 20.5
$BW_{Interferer}$	MHz	$BW_{Channel\_CA}$
$F_{Ioffset}$	MHz	+2*$BW_{Channel\_CA}$ / -2*$BW_{Channel\_CA}$ NOTE 5
$F_{Interferer}$	MHz	F_{DL_low} + 0.5*$BW_{Channel\_CA}$ To F_{DL_high} - 0.5*$BW_{Channel\_CA}$
NOTE 1: The interferer consists of the Reference measurement channel specified in Annex 3.2 with one sided dynamic OCNG Pattern as described in Annex A. and set-up according to Annex C. NOTE 2: The REFSENS power level is specified in Table 7.3.2-1. NOTE 3: The wanted signal consists of the reference measurement channel specified in Annex A.3.2 QPSK, R=1/3 with one sided dynamic OCNG pattern as described in Annex A and set-up according to Annex C. NOTE 4: The $F_{Interferer}$ (offset) is the frequency separation between the center of the aggregated CA bandwidth and the center frequency of the Interferer signal. NOTE 5: The absolute value of the interferer offset $F_{Interferer}$ (offset) shall be further adjusted to ([│ $F_{Interferer}$│/SCS] + 0.5)SCS $(\lceil \lvert F_{Interferer} \rvert / SCS \rceil + 0.5)SCS$ MHz with SCS the sub-carrier spacing of the wanted signal in MHz. Wanted and interferer signal have same SCS. NOTE 6: $F_{Interferer}$ range values for unwanted modulated interfering signals are interferer center frequencies.		

For intra-band non-contiguous carrier aggregation with two component carriers, the requirement applies to out-of-gap and in-gap. For out-of-gap, the UE shall meet the requirements for each component carrier with parameters as specified in 7.6.2-1. The requirement associated to the maximum channel between across the component carriers is selected. For in-gap, the requirement shall apply if the following minimum gap condition is met:

$$\Delta f_{IBB} \Delta f_{IBB} \geq 0.5(BW_1 + BW_2) + 2 \max(BW_1, BW_2),$$

where $\Delta f_{IBB} \Delta f_{IBB}$ is the frequency separation between the center frequencies of the component carriers and $BW_k/2$ are the channel bandwidths of carrier k, $k = 1,2$.

If the minimum gap condition is met, the UE shall meet the requirement specified in Table 7.6.2-1 for each component carrier. The respective channel bandwidth of the component carrier under test will be used in the parameter calculations of the requirement. In case of more than two component carriers, the minimum gap condition is computed for any pair of adjacent component carriers following the same approach as the two component carriers. The in-gap requirement for the corresponding pairs shall apply if the minimum gap condition is met.For every component carrier to which the requirements apply, the UE shall meet the requirement with one active interferer signal (in-gap or out-of-gap) while all downlink carriers are active.

For intra-band non-contiguous carrier aggregation with more than two component carriers or aggregated bandwidth $BW_{Channel\_CA}$ larger than 400MHz the requirement is FFS.

Table 7.6A.2-2: (Void)

7.6D Blocking characteristics for UL-MIMO

For UL-MIMO, the blocking characteristics requirements in subclause 7.6 apply. The requirements shall be met with the UL-MIMO configurations specified in Table 6.2D.1.3-3.

7.7 Spurious response

Detailed content of the subclause is TBD.

7.8 Void

7.9 Spurious emissions

The spurious emissions power is the power of emissions generated or amplified in a receiver. The spurious emissions power level is measured as TRP.

The power of any narrow band CW spurious emission shall not exceed the maximum level specified in Table 7.9-1. The requirement is verified in beam locked mode with the test metric of TRP (Link=TX beam peak direction).

Table 7.9-1: General receiver spurious emission requirements

Frequency band	Measurement bandwidth	Maximum level	NOTE
30MHz ≤ f < 1GHz	100 kHz	-57 dBm	1
1GHz ≤ f ≤ 2nd harmonic of the upper frequency edge of the DL operating band in GHz	1 MHz	-47 dBm	
NOTE 1: Unused PDCCH resources are padded with resource element groups with power level given by PDCCH_RA/RB as defined in Annex C.3.1.			

7.10 Receiver image

Detailed content of the subclause is TBD.

Annex A (normative): Measurement channels

Detailed content of the annex is TBD.

Annex B (normative): Propagation conditions

Detailed content of the annex is TBD.

Annex C (normative): Downlink physical channels

Detailed content of the annex is TBD.

Annex D (normative): Characteristics of the interfering signal

Detailed content of the annex is TBD.

Annex E (normative): Environmental conditions

E.1 General

This annex specifies the environmental requirements of the UE. Within these limits the requirements of the present documents shall be fulfilled.

E.2 Environmental

The requirements in this clause apply to all types of UE(s).

E.2.1 Temperature

All RF requirements for UEs operating in FR2 are defined over the air and can only be tested in an OTA chamber.

The UE shall fulfil all the requirements in the temperature range defined in Table E.2.1-1.

Table E.2.1-1: Temperature conditions

+ 25 ºC ± 10 ºC	For normal (room temperature) conditions with relative humidity of 25% to 75%
-10°C to +55°C	For extreme conditions

Outside this temperature range the UE, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in clause 6.2 for extreme operation.

E.2.2 Voltage

Editor's note: This requirement is incomplete. The following aspects are either missing or not yet determined:

Methodology to control the voltage in a case which a power cable is not connected to DUT is FFS since it is not agreed whether we can connect the power cable to DUT at the OTA measurement situation yet.

The UE shall fulfil all the requirements in the full voltage range, i.e. the voltage range between the extreme voltages.

The manufacturer shall declare the lower and higher extreme voltages and the approximate shutdown voltage. For the equipment that can be operated from one or more of the power sources listed below, the lower extreme voltage shall not be higher, and the higher extreme voltage shall not be lower than that specified below.

Table E.2.2-1: Voltage conditions

Power source	Lower extreme voltage	Higher extreme voltage	Normal conditions voltage
AC mains	0,9 * nominal	1,1 * nominal	nominal
Regulated lead acid battery	0,9 * nominal	1,3 * nominal	1,1 * nominal
Non regulated batteries: Leclanché Lithium Mercury/nickel & cadmium	 0,85 * nominal 0,95 * nominal 0,90 * nominal	 Nominal 1,1 * Nominal	 Nominal 1,1 * Nominal Nominal

Outside this voltage range the UE if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in clause 6.2 for extreme operation. In particular, the UE shall inhibit all RF transmissions when the power supply voltage is below the manufacturer declared shutdown voltage.

Annex F (informative): Change history

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2017-08	RAN4#84					Initial Skeleton	0.0.1
2017-10	RAN4#84 Bis	R4-1711979				TPs from R4#84Bis by editors	0.1.0
2017-12	RAN4#85	R4-1713806				Approved TPs from R4#85 R4-1714537, TP for TS 38.101-2: Channel Bandwidth Definition, Qualcomm Incorporated R4-1714115, TP for TS 38.101-2: Channel Arrangement, : Qualcomm Incorporated (Note: this TP was further discussed and edited in the reflector) R4-1713205, TP on general parts for 38.101-2 NR FR, : Ericsson R4-1712884, TP to TS38.101-2 on environmental conditions, Intel Corporation R4-1714018, TP to TS 38.101-2 for definition of UE RF terminologies, Anritsu Corporation R4-1714447, TP on UE power class for FR2, Intel Corporation R4-1714372, TP to TS38.101-2 on EVM equalizer spectrum flatness requirements, Intel Corporation R4-1714330, TP to TR 38.101-02 v0.1.0: ON/OFF mask design for NR UE transmissions for FR2, Ericsson R4-1714364, TP to TR 38.101: NR UE transmit OFF power for FR2, CATT R4-1714347, TP to TS38.101-2 on spurious emissions requirements for FR2, Intel Corporation (Note: this TP was further discussed and edited in the reflector) R4-1714456, TP on REFSENS for FR2, Intel Corporation R4-1714337 TP to TS 38.101-2 ACS requirement for mmW (section 7.5), Qualcomm Incorporated R4-1714338, TP to TS 38.101-2 IBB requirement for mmW (section 7.6.1), Qualcomm Incorporated R4-1714348, TP to TS38.101-2 on Rx spurious emissions for FR2, Intel Corporation Min power for EVM requirement according to R4-1711568, TP to TR 38.xxx - UE minimum transmit power for range 2, CATT Band list according to R4-1714542, List of bands and band combinations to be introduced into RAN4 NR core requirements by December 2017, RAN4 Chairmen	0.2.0
2017-12	RAN4#85	R4-1714570				Further corrections and alignments with 38.104 after email review	0.3.0
2017-12	RAN#78	RP-172476				v1.0.0 submitted for plenary approval. Contents same as 0.3.0	1.0.0
2017-12	RAN#78					Approved by plenary – Rel-15 spec under change control	15.0.0

2018-03	RAN#79	RP-180264	0004		F	Implementation of endorsed CR on to 38.101-2 Endorsed draft CRs in RAN4-NR-AH#1801 F: R4-1800918, Draft CR to 38.101-2 on channel bandwidth corrections (5.3.5), Nokia F: R4-1801097, Modification for TS38.101-2, CATT F: R4-1801098 Draft CR for TS38.101-2: On requirement metrics. Sumitomo Elec. Industries, Ltd F: R4-1800401, Editorial corections to 38.101-2, Qualcomm F: R4-1801122: Draft pCR for TS 38.101-2 version 15.0.0: Remaining ON/OFF masks for FR2 NR UE transmissions, Ericsson F: R4-1800418, Correction of NR SEM for FR2 table, vivo F: R4-1800316 Draft CR to 38.101-2: Tx spurious emission for NR FR2 (section 6.5.3), ZTE Corporation F: R4-1800918 Draft CR to 38.101-2 on channel bandwidth corrections (5.3.5), Nokia F: R4-1801013, Draft CR to 38.101-2: Clarifications to UE spectrum utilization section 5.3, Ericsson F: R4-1801229, Draft CR to 38.101-2: Channel spacing for CA for NR FR2(section 5.4.1.2), ZTE Corporation F: R4-1801232, Correction CR for channel spacing:38.101-2, Samsung F: R4-1801325, Draft CR to TS 38.101-2: Corrections on channel raster calculation in section 5.4.2, ZTE Corporation F: R4-1800860, Corrections of GSCN, Nokia Endorsed draft CRs in RAN4#86 R4-1803054, Draft CR for new spec structure of 38.101-2, Ericsson R4-1801446, Modification for NR UE time mask requirement for FR2, CATT R4-1801729, Draft CR to 38.101-2: Corrections to In-band blocking requirements, Rohde & Schwarz R4-1801967, CR on EVM spectrum flatness for FR2, Huawei R4-1802339, Draft CR to 38.101-2: Clarifications on peak directions and REFSENS, ROHDE & SCHWARZ R4-1802567, Draft CR to TS 38.101-2: Clarification of mixed numerology guardband size, Ericsson R4-1803238, Draft CR for TS 38.101-2: ACLR requirement clarification, Huawei R4-1803365, Draft CR to 38.101-2: Clarification on REFSENS Definition, ROHDE & SCHWARZ R4-1803453, draft CR for introduction of completed band combinations from 37.865-01-01 into 38.101-2, Ericsson R4-1803566, Draft CR for TS 38.101-2: Sync raster offset in re-farming bands (5.4.3), Ericsson	15.1.0

2018-06	RAN#80	RP-181262	0010		F	CR to TS 38.101-2: Implementation of endorsed draft CRs from RAN4 #86bis and RAN4 #87 Endorsed draft CRs from RAN4#86Bis R4-1803736, Draft CR on channel raster entry of band n258 for TS 38.101-2, ZTE Wistron Telecom AB R4-1804022, CR for modifications and clarifications for NR FR2 CA BW Classes, Nokia R4-1804585, Draft CR to 38.101-2: IBE Section Update, Qualcomm, Inc. R4-1804657, Introduction of UE to UE coexistence requirements requirements for FR2, Qualcomm Incorporated R4-1804949, Corrections to 5.3.3 in TS 38.101-2, Nokia R4-1805641, Corrections of BCS for n257 intraband contiguous CA in 38.101-2, Nokia R4-1805685, Draft CR to TS38.101-2: Channel Raster to Resource Element Mapping (Section 5.4.2.2) and RB alignment with different numerologies (Section 5.3.4), ZTE Corporation R4-1805704, Update of UE emission requirements for FR2, Qualcomm Incorporated R4-1805705, Draft CR to 38.101-2: Update of section 7.1, Rohde & Schwarz R4-1805757, Update of ACS requirement for FR2, Qualcomm Incorporated R4-1805771, Update of IBB requirement for FR2, Qualcomm Incorporated R4-1805775, draft CR for TS 38.101-2 on US 28 GHz band number, Qualcomm Incorporated R4-1805949, Draft CR on minimum guardband of SCS 240 kHz SSB for TS 38.101-2, ZTE Wistron Telecom AB R4-1805982, draft CR for 38.101-2: sync raster, Samsung R4-1804878, draft CR introduction completed band combinations 37.865-01-01 -> 38.101-2, Ericsson R4-1803628, pi/2 BPSK related CR, IITH Endorsed draft CRs from RAN#87 R4-1806167, Draft CR on channel raster entry of band n261 for TS 38.101-2, ZTE Corporation R4-1806169, Draft CR on SSB clarification for TS 38.101-2, ZTE Corporation R4-1806383, Draft CR of clarifications on TRx RF test metrics for mmWave, Anritsu Corporation R4-1806946, Draft CR for TS 38.101-2: Channel raster and NR-ARFCN clarification (5.4.2), Ericsson R4-1807652, FR2 UE ACLR requirement for CA, Qualcomm R4-1807655, Further refinements for UE Rx requirements in FR2, Qualcomm R4-1807681, Draft CR on 38.101-2 on channel raster to achieve alignment of data and SSB subcarrier grids, Nokia R4-1807853, Draft CR to TS 38.101-2: UE maximum output power for UL CA, Nokia R4-1807855, Draft CR on 38.101-2: Transmit ON/OFF time mask for UL CA, Nokia R4-1807857, Draft CR on 38.101-2: Occupied BW for UL CA, Nokia R4-1808101, Draft CR to 38.101-2: On EVM Averaging Length, Wording, Qualcomm Incorporated R4-1808105, Configured maximum output power for FR2, Ericsson R4-1808124, draft CR on UE RF requirement for UE type 2 in FR2, LG Electronics R4-1808125, Draft CR to TS 38.101-2: Minimum output and OFF Power, Nokia R4-1808147, Draft CR for NR FR2 CA BW class modifications, MediaTek Inc. R4-1808148, EVM equaliser spectral flatness for FR2, Ericsson R4-1808149, UE Shaping Filter Requirement for pi/2 BPSK, Indian Institute of Tech (M) R4-1808152, Draft CR for Finalizing UE RF Requirement for FWA, Samsung R4-1808266, Draft CR for TS 38.101-2: Channel and sync raster corrections (5.4), Ericsson R4-1808545, Draft CR on UE RF requirement for UE type 3 in FR2, Verizon R4-1808546, Power class 3 Spherical coverage introduction and peak EIRP requirement update, Qualcomm R4-1808206, Draft CR to 38.101-2: FR2 Type 1 UE Power Control, Qualcomm	15.2.0

						R4-1808208, Draft CR to 38.101-2: FR2 Type 1 UE CA EIS update, Qualcomm R4-1808191, TP to TS38.101-2 - UE ON/OFF masks, Ericsson R4-1807102, draft CR introduction completed band combinations 37.865-01-01 -> 38.101-2, Ericsson	

History

Document history		
V15.2.0	July 2018	Publication