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TECHNICAL SPECIFICATION

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Part 2: Range 2 Standalone
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Contents

Foreword

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

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

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The present document is part 2 of a multi-part Technical Specification (TS) covering the New Radio (NR) User Equipment (UE) conformance specification, which is divided in the following parts:

3GPP TS 38.521-1 [13]: NR; User Equipment (UE) conformance specification; Radio transmission and reception; Part 1: Range 1 Standalone;

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

3GPP TS 38.521-3 [14]: NR; User Equipment (UE) conformance specification; Radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios;

3GPP TS 38.521-4 [15]: NR; User Equipment conformance specification; Radio transmission and reception; Part 4: Performance;

3GPP TS 38.522 [16]: NR; User Equipment (UE) conformance specification; Applicability of RF and RRM test cases;

3GPP TS 38.533 [17]: NR; User Equipment (UE) conformance specification; Radio resource management;

1 Scope

The present document specifies the measurement procedures for the conformance test of the user equipment (UE) that contain RF characteristics for frequency Range 2 as part of the 5G-NR.

The requirements are listed in different clauses only if the corresponding parameters deviate. More generally, tests are only applicable to those mobiles that are intended to support the appropriate functionality. To indicate the circumstances in which tests apply, this is noted in the "*definition and applicability*" part of the test.

For example only Release 15 and later UE declared to support 5G-NR shall be tested for this functionality. In the event that for some tests different conditions apply for different releases, this is indicated within the text of the test itself.

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*.

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

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

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

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

[5] 3GPP TR 38.810: "Study on test methods for New Radio".

[6] ITU-R Recommendation 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] FCC 47 CFR Part 30: "UPPER MICROWAVE FLEXIBLE USE SERVICE, §30.202 Power limits".

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

[10] 3GPP TS 38.508-1: "5GS; User Equipment (UE) conformance specification; Part 1: Common test environment".

[11] 3GPP TS 38.508-2: "5GS; User Equipment (UE) conformance specification; Part 2: Common Implementation Conformance Statement (ICS) proforma".

[12] 3GPP TS 38.509: "5GS; Special conformance testing functions for User Equipment (UE)".

[13] 3GPP TS 38.521-1: "NR; User Equipment (UE) conformance specification; Radio transmission and reception; Part 1: Range 1 Standalone".

[14] 3GPP TS 38.521-3: "NR; User Equipment (UE) conformance specification; Radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios".

[15] 3GPP TS 38.521-4: "NR; User Equipment conformance specification; Radio transmission and reception; Part 4: Performance".

[16] 3GPP TS 38.522: "NR; User Equipment (UE) conformance specification; Applicability of RF and RRM test cases".

[17] 3GPP TS 38.533: "NR; User Equipment (UE) conformance specification; Applicability of RF and RRM test cases".

[18] 3GPP TS 38.300: "NR; Overall description; Stage 2".

[19] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification".

[20] 3GPP TR 38.903: "NR; Derivation of test tolerances and measurement uncertainty for User Equipment (UE) conformance tests ".

[21] 3GPP TR 38.905: "NR; Derivation of test points for radio transmission and reception conformance test cases".

[22] 3GPP TS 38.213: "NR; Physical layer procedures for control".

[23] 3GPP TS 38.214: "NR; Physical layer procedures for data".

[24] 3GPP TS 38.215: "NR; Physical layer measurements".

[25] 3GPP TS 38.133: "NR; Requirements for support of radio resource management".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

Editor’s note: intended to capture more definitions

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 emission 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 belongs 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 [5]

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 [5]

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.

UE transmission bandwidth configuration: Set of resource blocks located within the UE channel bandwidth which may be used for transmitting or receiving by the UE.

Vehicular UE: A UE embedded in a vehicle

3.2 Symbols

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

Editor's note: intended to capture more symbols

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_{RB}	The starting frequency offset between the allocated RB and the measured non-allocated RB
ΔR_{IB}	Allowed reference sensitivity relaxation due to support for inter-band CA operation
$\Delta MB_{P,n}$	Allowed relaxation to each, minimum peak EIRP and reference sensitivity due to support for multi-band operation, per band in a combination of supported bands
$\Delta MB_{S,n}$	Allowed relaxation to each, EIRP spherical coverage and EIS spherical coverage due to support for multi-band operation, per band in a combination of supported bands
$\sum MB_P$	Total allowed relaxation to each, minimum peak EIRP and reference sensitivity due to support for multi-band operation, for all bands in a combination of supported bands
$\sum MB_S$	Total allowed relaxation to each, EIRP spherical coverage and EIS spherical coverage due to support for multi-band operation, for all bands in a combination of supported bands
$BW_{Channel}$	Channel bandwidth
$BW_{Channel\_CA}$	Aggregated channel bandwidth, expressed in MHz.
BW_{GB}	max(BWGB,Channel(k))
$BW_{GB,Channel(k)}$	Minimum guard band defined in sub-clause 5.3.3 of carrier k
$BW_{interferer}$	Bandwidth of the interferer
Ceil(x)	Rounding upwards; ceil(x) is the smallest integer such that ceil(x) ≥ x
$EIRP_{max}$	The applicable maximum EIRP as specified in sub-clause 6.2.1
Floor(x)	Rounding downwards; floor(x) is the greatest integer such that floor(x) ≤ x
F_C	*RF reference frequency* for the carrier centre on the channel raster, given in table 5.4.2.2-1
$F_{C,block, high}$	Fc of the highest transmitted/received carrier in a sub-block.

$F_{C,block, low}$	Fc of the lowest transmitted/received carrier in a sub-block.
$F_{C, low}$	The Fc of the lowest carrier, expressed in MHz.
$F_{C, high}$	The Fc of the highest carrier, expressed in MHz.
$F_{edge, low}$	The lower edge of *Aggregated Channel Bandwidth*, expressed in MHz. $F_{edge, low} = F_{C, low} - F_{offset, low}$.
$F_{edge, high}$	The upper edge of *Aggregated Channel Bandwidth*, expressed in MHz. $F_{edge, high} = F_{C, high} + F_{offset, high}$.
$F_{edge,block,low}$	The lower sub-block edge, where $F_{edge,block,low} = F_{C,block,low} - F_{offset, low}$.
$F_{edge,block,high}$	The upper sub-block edge, where $F_{edge,block,high} = F_{C,block,high} + F_{offset, high}$.
$F_{Interferer}$ (offset)	Frequency offset of the interferer (between the centre frequency of the interferer and the carrier frequency of the carrier measured)
$F_{Interferer}$	Frequency of the interferer
$F_{offset, low}$	Frequency offset from $F_{C, low}$ to the lower *UE RF Bandwidth edge*, or from $F_{C,block, low}$ to the lower sub-block edge
$F_{offset, high}$	Frequency offset from $F_{C, high}$ to the upper *UE RF Bandwidth edge*, or from $F_{C,block, high}$ to the upper sub-block edge
F_center	The centre frequency of an allocated block of PRBs
F_{DL_low}	The lowest frequency of the downlink *operating band*
F_{DL_high}	The highest frequency of the downlink *operating band*
F_{UL_low}	The lowest frequency of the uplink *operating band*
F_{UL_high}	The highest frequency of the uplink *operating band*
$F_{Interferer}$ (offset)	Frequency offset of the interferer (between the centre frequency of the interferer and the carrier frequency of the carrier measured)
$F_{Interferer}$	Frequency of the interferer
$F_{Ioffset}$	Frequency offset of the interferer (between the centre frequency of the interferer and the closest edge of the carrier measured)
F_{OOB}	The boundary between the NR out of band emission and spurious emission domains
F_{REF}	RF reference frequency
$F_{REF-Offs}$	Offset used for calculating F_{REF}
F_{UL_Meas}	The sub-carrier frequency for which the equalizer coefficient is evaluated
$GB_{Channel}$	Minimum guard band defined in sub-clause 5.3.3
L_{CRB}	Transmission bandwidth which represents the length of a contiguous resource block allocation expressed in units of resources blocks
$L_{CRB,Max}$	Maximum number of RB for a given Channel bandwidth and sub-carrier spacing
Max()	The largest of given numbers
Min()	The smallest of given numbers
$MPR_{f,c}$	Maximum output power reduction for carrier *f* of serving cell *c*
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
n_{PRB}	Physical resource block number
NR_{ACLR}	NR ACLR
N_{RB}	Transmission bandwidth configuration, expressed in units of resource blocks
$N_{RB,low}$	Transmission bandwidth configurations according to Table 5.3.2-1 for the lowest assigned component carrier in section 5.3A.1
$N_{RB,high}$	Transmission bandwidth configurations according to Table 5.3.2-1 for the highest assigned component carrier in section 5.3A.1
N_{REF}	NR Absolute Radio Frequency Channel Number (NR-ARFCN)
$N_{REF-Offs}$	Offset used for calculating N_{REF}
P_{CMAX}	The configured maximum UE output power
$P_{CMAX, f, c}$	The configured maximum UE output power for carrier *f* of serving cell *c*
P_{max}	The maximum UE output power as specified in sub-clause 6.2.1
P_{min}	The minimum UE output power as specified in sub-clause 6.3.1
P_{int}	The intermediate power point as defined in table 6.3.4.2-2
$P_{Interferer}$	Modulated mean power of the interferer
$P\text{-}MPR_{f,c}$	The Power Management UE Maximum Power Reduction for carrier *f* of serving cell *c*
$P_{PowerClass}$	Nominal UE power class (i.e., no tolerance) as specified in sub-clause 6.2.1
P_{RB}	The transmitted power per allocated RB, measured in dBm
$P_{TMAX,f,c}$	The measured total radiated power for carrier *f* of serving cell *c*
P_{UMAX}	The measured configured maximum UE output power
Pw	Power of a wanted DL signal
RB_{start}	Indicates the lowest RB index of transmitted resource blocks
SCS_{low}	SCS for the lowest assigned component carrier in section 5.3A.1

SCS_{high} SCS for the highest assigned component carrier in section 5.3A.1
SS_{REF} SS block reference frequency position
T(ΔP) The tolerance T(ΔP) for applicable values of ΔP (values in dB)
TRP_{max} The maximum TRP for the UE power class as specified in sub-clause 6.2.1

3.3 Abbreviations

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

Editor's note: intended to capture more abbreviations.

ACLR Adjacent Channel Leakage Ratio
ACS Adjacent Channel Selectivity
A-MPR Additional Maximum Power Reduction
AoA Angle of Arrival
ARFCN Absolute Radio Frequency Channel Number
BPSK Binary Phase-Shift Keying
BS Base Station
BW Bandwidth
BWP Bandwidth Part
CA Carrier Aggregation
CA_nX-nY Inter-band CA of component carrier(s) in one sub-block within Band X and component carrier(s) in one sub-block within Band Y where X and Y are the applicable NR *operating band*
CC Component Carrier
CDF Cumulative Distribution Function
CHBW Channel Bandwidth
CP-OFDM Cyclic Prefix-OFDM
CW Continuous Wave
DFT-s-OFDM Discrete Fourier Transform-spread-OFDM
DL Downlink
DM-RS Demodulation Reference Signal
DTX Discontinuous Transmission
DUT Device Under Test
EIRP Effective Isotropic Radiated Power
EIS Effective Isotropic Sensitivity
EVM Error Vector Magnitude
FR Frequency Ranges
FWA Fixed Wireless Access
GSCN Global Synchronization Channel Number
IBB In-band Blocking
IDFT Inverse Discrete Fourier Transformation
ITU-R Radiocommunication Sector of the International Telecommunication Union
MBW Measurement bandwidth defined for the protected band
MPR Allowed maximum power reduction
NR New Radio
NR-ARFCN NR Absolute Radio Frequency Channel Number
OCNG OFDMA Channel Noise Generator
OOB Out-of-band
OTA Over The Air
P-MPR Power Management Maximum Power Reduction
PRB Physical Resource Block
QAM Quadrature Amplitude Modulation
RB Resource Blocks
REFSENS Reference Sensitivity
RF Radio Frequency
RIB Radiated Interface Boundary
RMS Root Mean Square (value)
RSRP Reference Signal Receiving Power
Rx Receiver
SCS Subcarrier Spacing

SEM	Spectrum Emission Mask
SRS	Sounding Reference Symbol
SS	Synchronization Symbol
TDD	Time Division Duplex
TPC	Transmission Power Control
TRP	Total Radiated Power
Tx	Transmitter
UE	User Equipment
UL	Uplink
UL-MIMO	Uplink Multiple Antenna transmission

4 General

4.1 Relationship between minimum requirements and test requirements

The TS 38.101-2 [3] is a Single-RAT specification for NR UE, covering RF characteristics and minimum performance requirements. Conformance to the TS 38.101-2 [3] is demonstrated by fulfilling the test requirements specified in the present document.

The Minimum Requirements given in TS 38.101-2 [3] make no allowance for measurement uncertainty. The measurement uncertainty defines in TR 38.903 [20]. The present document 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 TS 38.101-2 [3] 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.

d) All the requirements for intra-band contiguous and non-contiguous CA apply under the assumption of the same uplink-downlink and special subframe configurations in the PCell and SCells for SA.

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 either polarized UL MIMO or spatial UL MIMO. RF requirements are same. If UE supports both kinds of UL MIMO, then RF requirements only need to be verified under either polarized or spatial UL MIMO.	

4.4 Test point analysis

The information on test point analysis and test point selection including number of test points for each test case is shown in TR 38.905 [21] clause 4.2.

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 F_{UL_low} – F_{UL_high}	Downlink (DL) operating band BS transmit UE receive F_{DL_low} – F_{DL_high}	Duplex Mode
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)
FFS	FFS

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
n258
n260
n261

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.

The relationship between the channel bandwidth, the guardband and the transmission bandwidth configuration is shown in Figure 5.3.1-1.

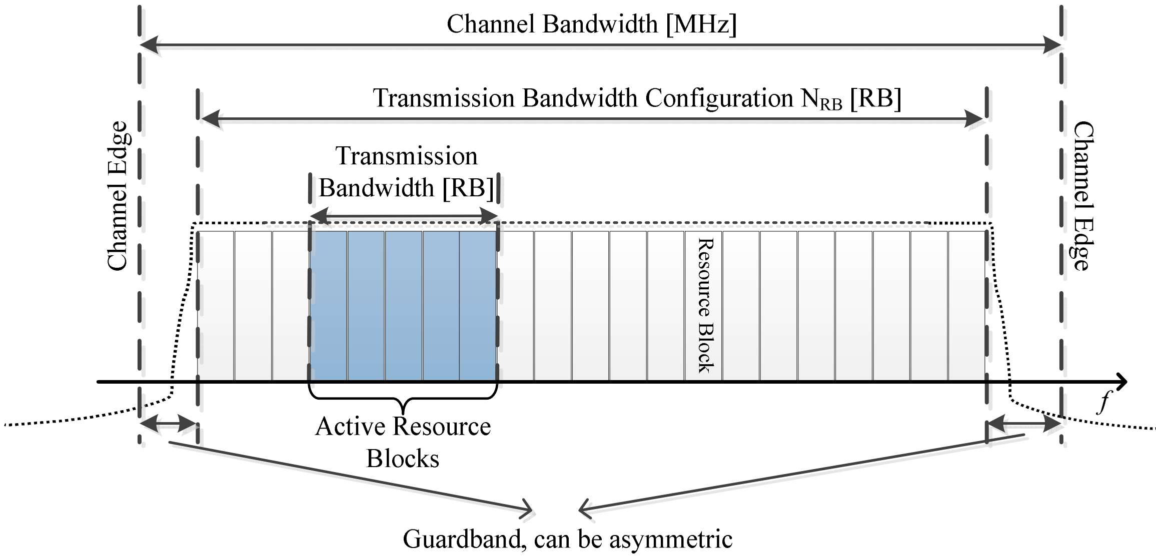

Figure 5.3.1-1: Definition of channel bandwidth and transmission bandwidth configuration for one NR channel

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
	NRB	NRB	NRB	NRB
60	66	132	264	N/A
120	32	66	132	264

5.3.3 Minimum guard band and transmission bandwidth configuration

The minimum guard band for each UE channel bandwidth and SCS is specified in Table 5.3.3-1.

Table 5.3.3-1: Minimum guard band 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 guard bands 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.

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.

Figure 5.3.3-1: Void

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

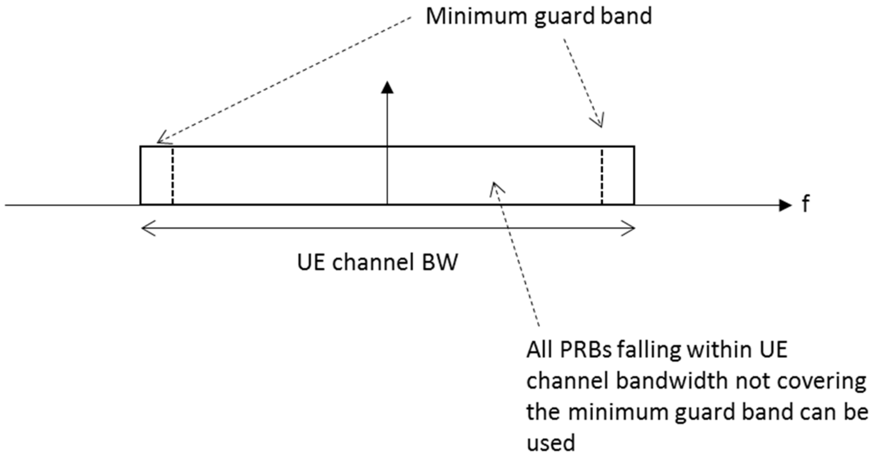

Figure 5.3.3-2: UE PRB utilization

In the case that multiple numerologies are multiplexed in the same symbol due to BS transmission of SSB, the minimum guard band on each side of the carrier is the guard band 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 >200MHz, the minimum guard band applied adjacent to 60 kHz SCS shall be the same as the minimum guard band defined for 120 kHz SCS for the same UE channel bandwidth.

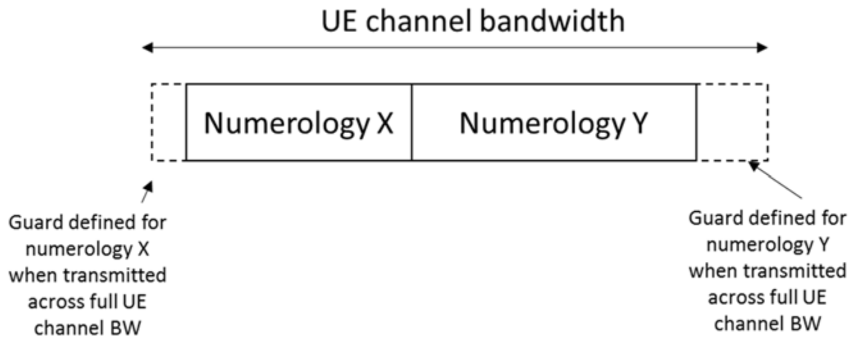

Figure 5.3.3-3: Guard band definition when transmitting multiple numerologies

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.

5.3.4 RB alignment

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 *UEtransmission bandwidth configuration* is indicated by the higher layer parameter *carrierBandwidth* [11] and will fulfil the minimum UE guard band 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	N/A
	120	Yes	Yes	Yes	Yes
n258	60	Yes	Yes	Yes	N/A
	120	Yes	Yes	Yes	Yes
n260	60	Yes	Yes	Yes	N/A
	120	Yes	Yes	Yes	Yes
n261	60	Yes	Yes	Yes	N/A
	120	Yes	Yes	Yes	Yes
NOTE 1: For test configuration tables from the transmitter and receiver tests in Section 6 and 7 that refer to this table and indicate test SCS to use, if referenced SCS value is not supported by the UE in UL and/or DL, select the closest SCS supported by the UE in both UL and DL.					

5.3A UE channel bandwidth for CA

5.3A.1 General

TBD

5.3A.2 Minimum guard band and transmission bandwidth configuration for CA

For intra-band contiguous carrier aggregation, *Aggregated Channel Bandwidth* and *Guard Bands* are defined as follows, see Figure 5.3A.2-1.

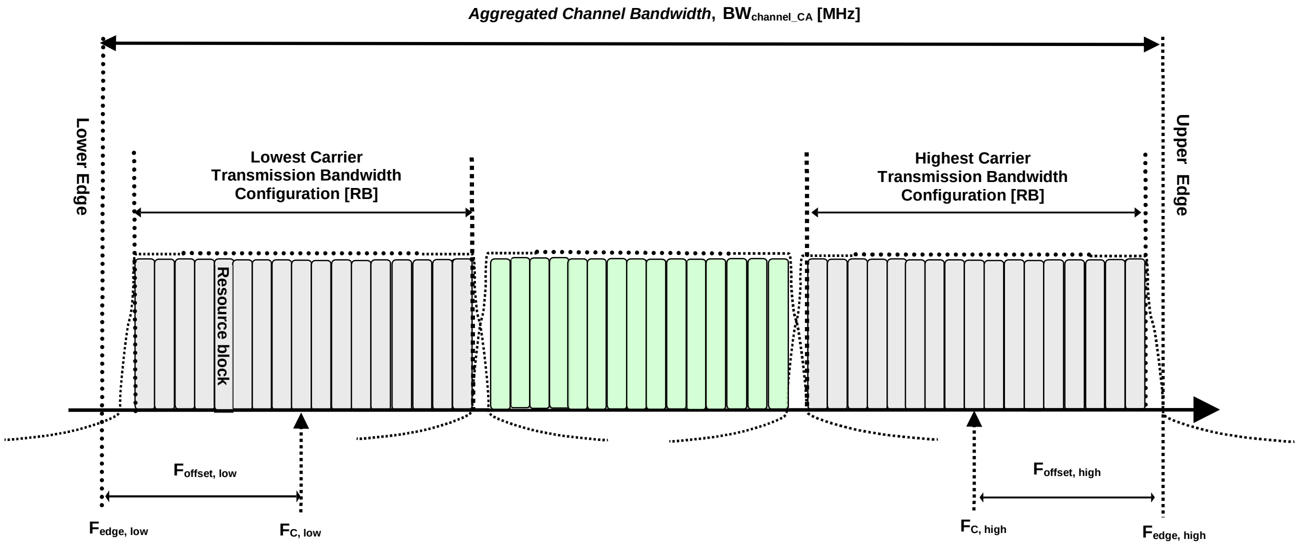

Figure 5.3A.2-1: Definition of *Aggregated Channel Bandwidth* for intra-band carrier aggregation

The *aggregated channel bandwidth,* $BW_{Channel\_CA}$, is defined as

$$BW_{Channel\_CA} = F_{edge,high} - F_{edge,low} \text{ (MHz)}.$$

The lower bandwidth edge $F_{edge,\ low}$ and the upper bandwidth edge $F_{edge,high}$ of the aggregated channel bandwidth are used as frequency reference points for transmitter and receiver requirements and are defined by

$$F_{edge,low} = F_{C,low} - F_{offset,low}$$

$$F_{edge,high} = F_{C,high} + F_{offset,high}$$

The lower and upper frequency offsets depend on the transmission bandwidth configurations of the lowest and highest assigned edge component carrier and are defined as

$$F_{offset,low} = (N_{RB,low}*12 + 1)*SCS_{low}/2 + BW_{GB} \text{ (MHz)}$$

$$F_{offset,high} = (N_{RB,high}*12 - 1)*SCS_{high}/2 + BW_{GB} \text{ (MHz)}$$

$$BW_{GB} = \max(BW_{GB,Channel(k)})$$

$BW_{GB,Channel(k)}$ is the minimum guard band defined in sub-clause 5.3.3 of carrier k, while $N_{RB,low}$ and $N_{RB,high}$ are the transmission bandwidth configurations according to Table 5.3.2-1 for the lowest and highest assigned component carrier, SCS_{low} and SCS_{high} are the sub-carrier spacing for the lowest and highest assigned component carrier respectively.

For intra-band non-contiguous carrier aggregation *Sub-block Bandwidth* and *Sub-block edges* are defined as follows, see Figure 5.3A.2-2.

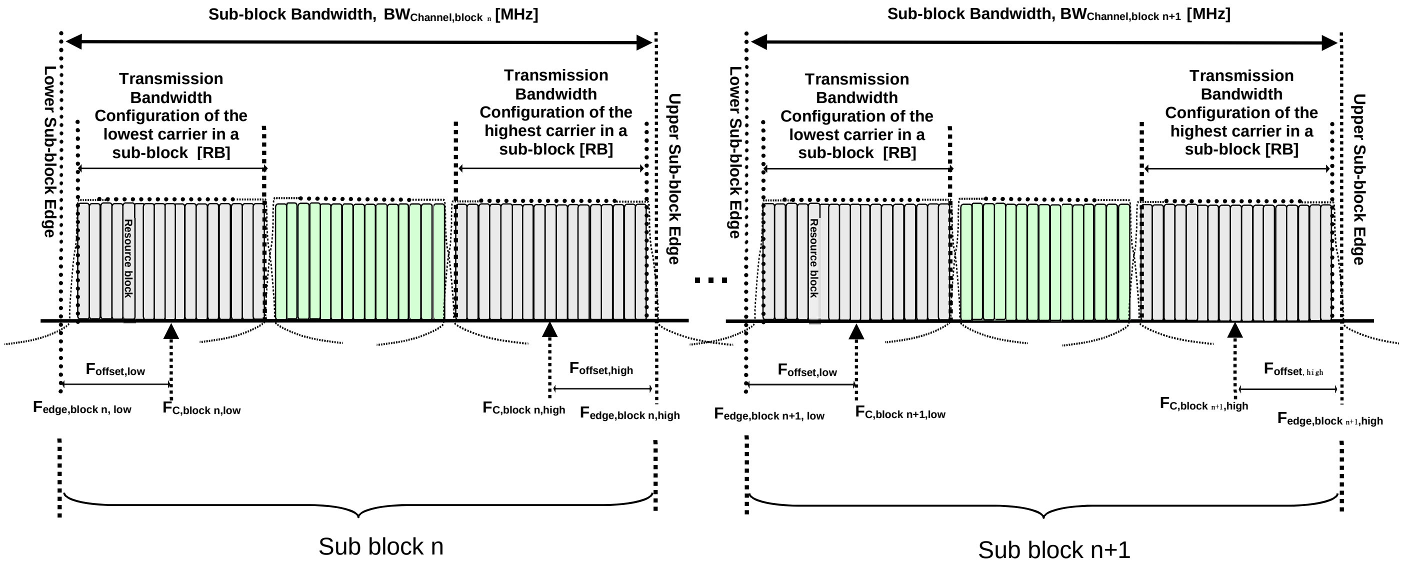

Figure 5.3A.2-2: Definition of sub-block bandwidth for intra-band non-contiguous spectrum

The lower sub-block edge of the Sub-block Bandwidth ($BW_{Channel,block}$) is defined as

$$F_{edge,block,\ low} = F_{C,block,low} - F_{offset,\ low.}$$

The upper sub-block edge of the Sub-block Bandwidth is defined as

$$F_{edge,block,high} = F_{C,block,high} + F_{offset,\ high.}$$

The Sub-block Bandwidth, $BW_{Channel,block}$, is defined as follows:

$$BW_{Channel,block} = F_{edge,block,high} - F_{edge,block,low} \text{ (MHz)}$$

The lower and upper frequency offsets $F_{offset,block,low}$ and $F_{offset,block,high}$ depend on the transmission bandwidth configurations of the lowest and highest assigned edge component carriers within a sub-block and are defined as

$$F_{offset,block,low} = (N_{RB,low}*12 + 1)*SCS_{low}/2 + BW_{GB} \text{ (MHz)}$$

$$F_{offset,block,high} = (N_{RB,high}*12 - 1)*SCS_{high}/2 + BW_{GB} \text{ (MHz)}$$

$$BW_{GB} = \max(BW_{GB,Channel(k)})$$

where $N_{RB,low}$ and $N_{RB,high}$ are the transmission bandwidth configurations according to Table 5.3.2-1 for the lowest and highest assigned component carrier within a sub-block, respectively. SCS_{low} and SCS_{high} are the sub-carrier spacing for the lowest and highest assigned component carrier within a sub-block, respectively. $BW_{GB,Channel(k)}$ is the minimum guard band defined in sub-clause 5.3.3 of carrier k within a sub-block.

The sub-block gap size between two consecutive sub-blocks W_{gap} is defined as

$$W_{gap} = F_{edge,block\ n+1,low} - F_{edge,block\ n,high} \text{ (MHz)}$$

5.3A.3 RB alignment with different numerologies for CA

TBD

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, A 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	$BW_{Channel}$ ≤ 400 MHz	1	
B	400 MHz < $BW_{Channel\_CA}$ ≤ 800 MHz	2	1
C	800 MHz < $BW_{Channel\_CA}$ ≤ 1200 MHz	3	
D	200 MHz < $BW_{Channel\_CA}$ ≤ 400 MHz	2	2
E	400 MHz < $BW_{Channel\_CA}$ ≤ 600 MHz	3	
F	600 MHz < $BW_{Channel\_CA}$ ≤ 800 MHz	4	
G	100 MHz < $BW_{Channel\_CA}$ ≤ 200 MHz	2	3
H	200 MHz < $BW_{Channel\_CA}$ ≤ 300 MHz	3	
I	300 MHz < $BW_{Channel\_CA}$ ≤ 400 MHz	4	
J	400 MHz < $BW_{Channel\_CA}$ ≤ 500 MHz	5	
K	500 MHz < $BW_{Channel\_CA}$ ≤ 600 MHz	6	
L	600 MHz < $BW_{Channel\_CA}$ ≤ 700 MHz	7	
M	700 MHz < $BW_{Channel\_CA}$ ≤ 800 MHz	8	
O	100 MHz ≤ $BW_{Channel\_CA}$ ≤200 MHz	2	4
P	150 MHz ≤ $BW_{Channel\_CA}$ ≤300 MHz	3	
Q	200 MHz ≤ $BW_{Channel\_CA}$ ≤ 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 belongs 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 – 3279167

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}.

The mapping between the channel raster and corresponding resource element is given in subclause 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

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

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, $\Delta F_{Raster} = I \times \Delta F_{Global}$, where $I \in \{1,2\}$.
- 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	ΔF_{Raster} (kHz)	Uplink and Downlink Range of N_{REF} (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> – 2084999

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 are 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*17.28MHz, 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 given 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 [22].			

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

TBD

5.5A Configurations for CA

5.5A.1 Configurations for intra-band contiguous CA

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

NR CA configuration / Bandwidth combination set / Fallback group												
NR CA configuration	Uplink CA configurations	Component carriers in order of increasing carrier frequency								Maximum aggregated BW (MHz)	BCS	Fallback group
		CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)			
CA_n257B	CA_n257B	50	400							450	0	1
		100	400							500		
		200	400							600		
		400	400							800		
CA_n257D	CA_n257D	50	200							250	0	2
		100	200							300		
		200	200							400		

CA_n257E	CA_n257E	50	200	200						450	0	
		100	200	200						500		
		200	200	200						600		
CA_n257F	CA_n257F	50	200	200	200					650	0	
		100	200	200	200					700		
		200	200	200	200					800		
CA_n257G	CA_n257G	100	100							200	0	3
CA_n257H	CA_n257H	100	100	100						300	0	
CA_n257I	CA_n257I	100	100	100	100					400	0	
CA_n257J	CA_n257J	100	100	100	100	100				500	0	
CA_n257K	CA_n257K	100	100	100	100	100	100			600	0	
CA_n257L	CA_n257L	100	100	100	100	100	100	100		700	0	
CA_n257M	CA_n257M	100	100	100	100	100	100	100	100	800	0	
CA_n260B	CA_n260B	50, 100, 200, 400	400							800	0	1
CA_n260C	CA_n260B	50, 100, 200, 400	400	400						1200	0	
CA_n260D	CA_n260D	50, 100, 200	200							400	0	2
		200	50, 100, 200									
CA_n260E	CA_n260E	50, 100, 200	200	200						600	0	
		200	200	50, 100, 200								
CA_n260F	CA_n260F	50, 100, 200	200	200	200					800	0	
CA_n260G	CA_n260G	100	50, 100							200	0	3
		50, 100	100									
CA_n260H	CA_n260H	100	100	50, 100						300	0	
CA_n260I	CA_n260I	100	100	100	50, 100					400	0	
		50, 100	100	100	100							
CA_n260J	CA_n260J	100	100	100	100	50, 100				500	0	
CA_n260K	CA_n260K	100	100	100	100	100	50, 100			600	0	
CA_n260L	CA_n260L	100	100	100	100	100	100	50, 100		700	0	
CA_n260M	CA_n260M	100	100	100	100	100	100	100	50, 100	800	0	
CA_n260O	CA_n260O	50, 100	50, 100							200	0	4
CA_n260P	CA_n260P	50, 100	50, 100	50, 100						300	0	

CA_n260Q	CA_n260Q	50, 100	50, 100,	50, 100	50, 100					400	0	
CA_n261B	CA_n261B	50, 100, 200, 400	400							800	0	1
CA_n261C	CA_n261B	50, 100, 200, 400	400	400						850[1]	0	
CA_n261D	CA_n261D	50, 100, 200	200							400	0	2
		200	50, 100, 200									
CA_n261E	CA_n261E	50, 100, 200	200	200						600	0	
		200	200	50, 100, 200								
CA_n261F	CA_n261F	50, 100, 200	200	200	200					800	0	
CA_n261G	CA_n261G	100	50, 100							200	0	3
		50, 100	100									
CA_n261H	CA_n261H	100	100	50, 100						300	0	
		50, 100	100	100								
CA_n261I	CA_n261I	100	100	100	50, 100					400	0	
		50, 100	100	100	100							
CA_n261J	CA_n261J	100	100	100	100	50, 100				500	0	
CA_n261K	CA_n261K	100	100	100	100	100	50, 100			600	0	
CA_n261L	CA_n261L	100	100	100	100	100	100	50, 100		700	0	
CA_n261M	CA_n261M	100	100	100	100	100	100	100	50, 100	800	0	
		50,100	100	100	100	100	100	100	100			
CA_n261O	CA_n261O	50, 100	50, 100							200	0	4
CA_n261P	CA_n261P	50, 100	50, 100	50, 100						300	0	
CA_n261Q	CA_n261Q	50, 100	50, 100,	50, 100	50, 100					400	0	
NOTE 1: The maximum bandwidth of band n261 is 850MHz.												

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

Configurations listed in this clause apply to downlink carrier aggregation only.

Table 5.5A.2-1: NR CA configurations with single CA bandwidth class 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)	BCS
			CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)		
CA_n257(2A)	-	60	50, 100, 200	50, 100, 200				400	0
		120	50, 100, 200, 400	50, 100, 200, 400				800	
CA_n260(2A)	-	60	50, 100, 200	50, 100, 200				400	0
		120	50, 100, 200, 400	50, 100, 200, 400				800	
CA_n260(3A)	-	60	50, 100, 200	50, 100, 200	50, 100, 200			600	0
		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	0
		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	0
		120	50, 100, 200, 400	50, 100, 200, 400				800	
CA_n261(3A)	-	60	50, 100, 200	50, 100, 200	50, 100, 200			600	0
		120	50, 100, 200, 400	50, 100, 200, 400	50, 100, 200, 400			700[1]	
CA_n261(4A)	-	60	50, 100, 200	50, 100, 200	50, 100, 200	50, 100, 200		700[1]	0
		120	50, 100, 200, 400	50, 100, 200, 400	50, 100, 200, 400	50, 100, 200, 400		700[1]	
NOTE 1: The maximum bandwidth of band n261 is 850MHz and a non-contiguous gap is in between NR component carriers.									

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

				NR configuration / Bandwidth combination s				
Uplink CA configurations (NOTE 1)	Component carriers in order of increasing carrier frequency							
	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MHz)	CBW (MH
-	See CA_n260D BCS05.5A.1-1 in Table		See CA_n260G BCS0 in Table 5.5A.1-1					
	See CA_n260G BCS0 in Table 5.5A.1-1		See CA_n260D BCS0 in Table 5.5A.1-1					
-	See CA_n260D BCS0 in Table 5.5A.1-1		See CA_n260H BCS0 in Table 5.5A.1-1					
	See CA_n260H BCS0 in Table 5.5A.1-1		See CA_n260D BCS0 in Table 5.5A.1-1					
-	See CA_n260D BCS0 in Table 5.5A.1-1		See CA_n260I BCS0 in Table 5.5A.1-1					
	See CA_n260I BCS0 in Table 5.5A.1-1		See CA_n260D BCS0 in Table 5.5A.1-1					
-	See CA_n260D BCS0 in Table 5.5A.1-1		See CA_n260O BCS0 in Table 5.5A.1-1					
	See CA_n260O BCS0 in Table 5.5A.1-1		See CA_n260D BCS0 in Table 5.5A.1-1					
-	See CA_n260D BCS0 in Table 5.5A.1-1		See CA_n260P BCS0 in Table 5.5A.1-1					
	See CA_n260P BCS0 in Table 5.5A.1-2		See CA_n260D BCS0 in Table 5.5A.1-2					
-	See CA_n260D BCS0 in Table 5.5A.1-1		See CA_n260Q BCS0 in Table 5.5A.1-1					
	See CA_n260Q BCS0 in Table 5.5A.1-1		See CA_n260D BCS0 in Table 5.5A.1-1					
-	See CA_n260E BCS0 in Table 5.5A.1-1		See CA_n260O BCS0 in Table 5.5A.1-1					
	See CA_n260O BCS0 in Table 5.5A.1-1		See CA_n260E BCS0 in Table 5.5A.1-1					
-	See CA_n260E BCS0 in Table 5.5A.1-1		See CA_n260P BCS0 in Table 5.5A.1-1					
	See CA_n260P BCS0 in Table 5.5A.1-1		See CA_n260E BCS0 in Table 5.5A.1-1					
-	See CA_n260E BCS0 in Table 5.5A.1-1		See CA_n260Q BCS0 in Table 5.5A.1-1					
	See CA_n260Q BCS0 in Table 5.5A.1-1		See CA_n260E BCS0 in Table 5.5A.1-1					
-	See CA_n261D BCS0 in Table 5.5A.1-1		See CA_n261G BCS0 in Table 5.5A.1-1					
	See CA_n261G BCS0 in Table 5.5A.1-1		See CA_n261D BCS0 in Table 5.5A.1-1					
-	See CA_n261D BCS0 in Table 5.5A.1-1		See CA_n261H BCS0 in Table 5.5A.1-1					
	See CA_n261H BCS0 in Table 5.5A.1-1		See CA_n261D BCS0 in Table 5.5A.1-1					
-	See CA_n261D BCS0 in Table 5.5A.1-1		See CA_n261I BCS0 in Table 5.5A.1-1					
	See CA_n261I BCS0 in Table 5.5A.1-1		See CA_n261D BCS0 in Table 5.5A.1-1					
-	See CA_n261D BCS0 in Table 5.5A.1-1		See CA_n261O BCS0 in Table 5.5A.1-1					
	See CA_n261O BCS0 in Table 5.5A.1-1		See CA_n261D BCS0 in Table 5.5A.1-1					
-	See CA_n261D BCS0 in Table 5.5A.1-1		See CA_n261P BCS0 in Table 5.5A.1-1					
	See CA_n261P BCS0 in Table 5.5A.1-1		See CA_n261D BCS0 in Table 5.5A.1-1					

-	See CA_n261D BCS0 in Table 5.5A.1-1	See CA_n261Q BCS0 in Table 5.5A.1-1			
	See CA_n261Q BCS0 in Table 5.5A.1-1	See CA_n261D BCS0 in Table 5.5A.1-1			
-	See CA_n261E BCS0 in Table 5.5A.1-1	See CA_n261O BCS0 in Table 5.5A.1-1			
	See CA_n261O BCS0 in Table 5.5A.1-1	See CA_n261E BCS0 in Table 5.5A.1-1			
-	See CA_n261E BCS0 in Table 5.5A.1-1	See CA_n261P BCS0 in Table 5.5A.1-1			
	See CA_n261P BCS0 in Table 5.5A.1-1	See CA_n261E BCS0 in Table 5.5A.1-1			
-	See CA_n261E BCS0 in Table 5.5A.1-1	See CA_n261Q BCS0 in Table 5.5A.1-1			
	See CA_n261Q BCS0 in Table 5.5A.1-1	See CA_n261E BCS0 in Table 5.5A.1-1			
mum bandwidth of band n261 is 850MHz and a non-contiguous gap is in between NR component carriers.					

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

Editor's Note:

- Test configurations/environments that require new spherical scan shall be included in test procedure section and identifying such scenarios is currently FFS and owned by RAN5.

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

For Tx test cases the identified beam peak direction can be stored and reused for a device under test in various configurations/environments for the full duration of device testing as long as beam peak direction is the same.

Unless otherwise stated, Channel Bandwidth shall be prioritized in the selecting of test points. Subcarrier spacing shall be selected after Test Channel Bandwidth is selected.

Uplink RB allocations given in Table 6.1-1 are used throughout this section, unless otherwise stated by the test case.

Table 6.1-1: Common Uplink Configuration

Channel Bandwidth	SCS(kHz)	OFDM	RB allocation					
			Outer_Full	Outer_1RB_Left	Outer_1RB_Right	Inner_Full	Inner_1RB_Left	Inner_1RB_Right
50MHz	60	DFT-s	64@0	1@0	1@65	[TBD]	[TBD]	[TBD]
		CP	66@0	1@0	1@65	[TBD]	[TBD]	[TBD]
	120	DFT-s	32@0	1@0	1@31	[TBD]	[TBD]	[TBD]
		CP	32@0	1@0	1@31	[TBD]	[TBD]	[TBD]
100MHz	60	DFT-s	128@0	1@0	1@131	[TBD]	[TBD]	[TBD]
		CP	132@0	1@0	1@131	[TBD]	[TBD]	[TBD]
	120	DFT-s	64@0	1@0	1@65	[TBD]	[TBD]	[TBD]
		CP	66@0	1@0	1@65	[TBD]	[TBD]	[TBD]
200MHz	60	DFT-s	256@0	1@0	1@263	[TBD]	[TBD]	[TBD]
		CP	264@0	1@0	1@263	[TBD]	[TBD]	[TBD]
	120	DFT-s	128@0	1@0	1@131	[TBD]	[TBD]	[TBD]
		CP	132@0	1@0	1@131	[TBD]	[TBD]	[TBD]
400MHz	60	DFT-s	N/A	N/A	N/A	[TBD]	[TBD]	[TBD]
		CP	N/A	N/A	N/A	[TBD]	[TBD]	[TBD]
	120	DFT-s	256@0	1@0	1@263	[TBD]	[TBD]	[TBD]
		CP	264@0	1@0	1@263	[TBD]	[TBD]	[TBD]

6.2 Transmit power

6.2.1 UE maximum output power

6.2.1.0 General

Note : Power class 1, 2, 3, and 4 are specified based on the assumption of certain UE types with specific device architectures. The UE types can be found in Table6.2.1-1.

Table 6.2.1-1: Assumption of UE Types

UE Power class	UE type
1	Fixed wireless access(FWA) UE
2	Vehicular UE
3	Handheld UE
4	High power non-handheld UE

6.2.1.1 UE maximum output power - EIRP and TRP

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

- Measurement Uncertainties and Test Tolerances are FFS for power class 1, 2 and 4.
- The procedure to ensure UE is at maximum output power is TBD.

6.2.1.1.1 Test purpose

To verify that the error of the UE maximum output power does not exceed the range prescribed by the specified nominal maximum output power and tolerance.

An excess maximum output power has the possibility to interfere to other channels or other systems. A small maximum output power decreases the coverage area.

6.2.1.1.2 Test applicability

This test case applies to all types of NR UE release 15 and forward.

6.2.1.1.3 Minimum conformance requirements

6.2.1.1.3.1 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).

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 85th 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 NOTE 2: The requirements in this table are verified only under normal temperature conditions as defined in Annex E.2.1.	

6.2.1.1.3.2 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
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
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
n261	18.0
NOTE 1: Minimum EIRP at 60%-tile CDF is defined as the lower limit without tolerance NOTE 2: The requirements in this table are verified only under normal temperature conditions as defined in Annex E.2.1.	

6.2.1.1.3.3 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 requirement is verified with the test metric of total component of EIRP, as defined in [5] (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 NOTE 2: The requirements in this table are only applicable for UE which supports single band in FR2	

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 the total component of EIRP, as defined in [5] (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 the total component of EIRP, as defined in [5] (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 50^{t}%-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 NOTE 3: The requirements in this table are verified only under normal temperature conditions as defined in Annex E.2.1.	

For the UEs that support operation in multiple FR2 bands, minimum requirement for peak EIRP and EIRP spherical coverage in Tables 6.2.1.3-1 and 6.2.1.3-3 shall be decreased per band, respectively, by the peak EIRP relaxation parameter $\Delta MB_{P,n}$ and EIRP spherical coverage relaxation parameter $\Delta MB_{S,n}$ as specified in Table 6.2.1.3-4. For each combination of supported bands $\Delta MB_{P,n}$ and $\Delta MB_{S,n}$ apply to each supported band *n*, such that the total relaxations, $\sum MB_P$ and $\sum MB_S$, across all supported bands does not exceed the total value indicated.

Table 6.2.1.3-4: UE multi-band relaxation factors for power class 3

Supported bands	$\sum MB_P$ (dB)	$\sum MB_S$ (dB)
n257, n258	≤ 1.3	≤ 1.25
n258, n260	≤ 1.0	≤ 0.75[3]
n258, n261	≤ 1.0	≤ 1.25
n260, n261	0.0	≤ 0.75[2]
n257, n258, n261	≤ 1.7	≤ 1.75
n257, n260, n261	≤ 0.5	≤ 1.25[3]
n258, n260, n261	≤ 1.5	≤ 1.25[3]
n257, n258, n260, n261	≤ 1.7	≤ 1.75[3]
NOTE 1: The requirements in this table are applicable to UEs which support only the indicated bands NOTE 2: For supported bands n260 + n261, $\Delta MB_{S,n}$ is not applied for band n260 NOTE 3: For n260, maximum applicable $\Delta MB_{S,n}$ is 0.4 dB		

6.2.1.1.3.4 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 20^{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 6.2.1.4-3 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 NOTE 2: The requirements in this table are verified only under normal temperature conditions as defined in Annex E.2.1.	

The normative reference for this requirement is TS 38.101-2 [3] clause 6.2.1.

6.2.1.1.4 Test description

6.2.1.1.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, and channel bandwidths based on NR operating bands specified in table 5.3.5-1. All of these configurations shall be tested with applicable test parameters for each channel bandwidth and subcarrier spacing, are shown in table 6.2.1.1.4.1-1. The details of the uplink reference measurement channels (RMCs) are specified in Annexes A.2. Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2.

Table 6.2.1.1.4.1-1: Test Configuration Table

Default Conditions					
Test Environment as specified in TS 38.508-1 [10] subclause [4.1]			Normal		
Test Frequencies as specified in TS 38.508-1 [10] subclause [4.3.1]			Low range, Mid Range, High range		
Test Channel Bandwidths as specified in TS 38.508-1 [10] subclause [4.3.1]			100 MHz		
Test SCS as specified in Table 5.3.5-1			60 kHz		
Test Parameters					
Test ID	**ChBw**	**SCS**	**Downlink Configuration**	**Uplink Configuration**	
	Default	Default	N/A	**Modulation**	**RB allocation (NOTE 1)**
1				DFT-s-OFDM QPSK	Outer_Full
NOTE 1: The specific configuration of each RF allocation is defined in Table 6.1-1.					

1. Connection between SS and UE is shown in TS 38.508-1 [10] Annex A, Figure A.3.3.1.1 for TE diagram and Figure A.3.4.1.1 for UE diagram..

2. The parameter settings for the cell are set up according to TS 38.508-1 [10] subclause 4.4.3.

3. Downlink signals are initially set up according to Annex C.2 and TS 38.508-1 [10] subclause 5.2.1.1.1, and uplink signals according to Annex G.0, G.1 and G.3.0.

4. The UL Reference Measurement channels are set according to Table 6.2.1.1.4.1-1.

5. Propagation conditions are set according to Annex B.0

6. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity *NR*, Connected without release *On* according to TS 38.508-1 [10] clause 4.5. Message contents are defined in clause 6.2.1.1.4.3

6.2.1.1.4.2 Test procedure

1. Set the UE in the Tx beam peak direction found with a 3D EIRP scan as performed in Annex K.

2. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format [0_1] for C_RNTI to schedule the UL RMC according to Table 6.2.1.1.1.4.1-1. Since the UL has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC. Messages to configure the appropriate uplink modulation in section 6.2.1.1.4.3.

3. Send continuously uplink power control "up" commands in every uplink scheduling information to the UE; allow at least [TBD msec] starting from the first TPC command in this step to ensure that the UE transmits at its maximum output power.

4. SS activates the UE Beamlock Function (UBF) by performing the procedure as specified in TS 38.508-1 [10] clause 4.9.2 using condition Tx only.

5. Measure UE EIRP in the Tx beam peak direction in the channel bandwidth of the radio access mode according to the test configuration, which shall meet the requirements described in Table 6.3.1.5-1. EIRP test procedure is defined in Annex K. The measuring duration is one active uplink subframe. EIRP is calculated considering both polarizations, theta and phi.

6. Measure TRP of the transmitted signal for the assigned NR channel with a rectangular measurement filter with bandwidths according to Table 6.5.2.3.5-1. Total radiated power is measured according to TRP measurement procedure defined in Annex L and measurement grid specified in [TBD]. TRP is calculated considering both polarizations, theta and phi.

7. SS deactivates the UE Beamlock Function (UBF) by performing the procedure as specified in TS 38.508-1 [10] clause 4.9.3.

6.2.1.1.4.3 Message contents

Message contents are according to TS 38.508-1 [10] subclause 4.6.

6.2.1.1.5 Test requirement

The EIRP derived in step 4 and TRP derived in step 5 shall not exceed the values specified in Table 6.2.1.1.5-1 to Table 6.2.1.1.5-4.

Table 6.2.1.1.5-1: UE maximum output test requirements for power class 1

Operating band	Max TRP (dBm)	Max EIRP (dBm)	Min peak EIRP (dBm)
n257	35+TT	55	40.0-TT
n258	35+TT	55	40.0-TT
n260	35+TT	55	38.0-TT
n261	35+TT	55	40.0-TT

Table 6.2.1.1.5-2: UE maximum output test requirements for power class 2

Operating band	Max TRP (dBm)	Max EIRP (dBm)	Min peak EIRP (dBm)
n257	23+TT	43	29-TT
n258	23+TT	43	29-TT
n260			
n261	23+TT	43	29-TT

Table 6.2.1.1.5-3: UE maximum output test requirements for power class 3

Operating band	Max TRP (dBm)	Max EIRP (dBm)	Min peak EIRP (dBm)
n257	23+TT	43	22.4-TT
n258	23+TT	43	22.4-TT
n260	23+TT	43	20.6-TT
n261	23+TT	43	22.4-TT

Table 6.2.1.1.5-3a: Test Tolerance (Max TRP for Power class 3)

Test Metric	FR2a	FR2b
IFF (DUT ≤ 15 cm)	[2.8] dB	[3.0] dB
IFF (DUT ≤ 30 cm)	[2.7] dB	[3.0] dB

Table 6.2.1.1.5-3b: Test Tolerance (Min peak EIRP for Power class 3)

Test Metric	FR2a	FR2b
IFF (DUT ≤ 15 cm)	[2.9] dB	[3.1] dB
IFF (DUT ≤ 30 cm)	[2.8] dB	[3.0] dB

Table 6.2.1.1.5-4: UE maximum output power test requirements for power class 4

Operating band	Max TRP (dBm)	Max EIRP (dBm)	Min peak EIRP (dBm)
n257	23+TT	43	34-TT
n258	23+TT	43	34-TT
n260	23+TT	43	31-TT
n261	23+TT	43	34-TT

6.2.1.2 UE maximum output power - Spherical coverage

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

- Measurement Uncertainties and Test Tolerances are FFS.
- The procedure to ensure UE is at maximum output power is TBD.

6.2.1.2.1 Test purpose

To verify that the spatial coverage of the UE in expected directions is acceptable.

6.2.1.2.2 Test applicability

This test case applies to all types of NR UE release 15 and forward.

6.2.1.2.3 Minimum conformance requirements

Minimum conformance requirements are defined in clause 6.2.1.1.3.

6.2.1.2.4 Test description

6.2.1.2.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, and channel bandwidths based on NR operating bands specified in table 5.3.5-1. All of these configurations shall be tested with applicable test parameters for each channel bandwidth and subcarrier spacing, are shown in table 6.2.1.2.4.1-1. The details of the uplink reference measurement channels (RMCs) are specified in Annexes A.2. Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2.

Table 6.2.1.2.4.1-1: Test Configuration Table

Default Conditions					
Test Environment as specified in TS 38.508-1 [10] subclause [4.1]				Normal	
Test Frequencies as specified in TS 38.508-1 [10] subclause [4.3.1]				Low range, Mid Range, High range	
Test Channel Bandwidths as specified in TS 38.508-1 [10] subclause [4.3.1]				100 MHz	
Test SCS as specified in Table 5.3.5-1				60 kHz	
Test Parameters					
Test ID	**ChBw**	**SCS**	**Downlink Configuration**	**Uplink Configuration**	
	Default	Default	N/A	**Modulation**	**RB allocation (NOTE 1)**
1				DFT-s-OFDM QPSK	Outer_Full
NOTE 1: The specific configuration of each RF allocation is defined in Table 6.1-1.					

1. Connection between SS and UE is shown in TS 38.508-1 [10] Annex A, Figure A.3.3.1.1 for TE diagram and Figure A.3.4.1.1 for UE diagram.
2. The parameter settings for the cell are set up according to TS 38.508-1 [10] subclause 4.4.3.
3. Downlink signals are initially set up according to Annex C.2 and TS 38.508-1 [10] subclause 5.2.1.1.1, and uplink signals according to Annex G.0, G.1 and G.3.0.
4. The UL Reference Measurement channels are set according to Table 6.2.1.2.4.1-1.
5. Propagation conditions are set according to Annex B.0.
6. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity *NR*, Connected without release *On* according to TS 38.508-1 [10] clause 4.5. Message contents are defined in clause 6.2.1.2.4.3

6.2.1.2.4.2 Test procedure

1. Set the UE in the Tx beam peak direction found with a 3D EIRP scan as performed in Annex K.
2. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format [0_1] for C_RNTI to schedule the UL RMC according to Table 6.2.1.2.1.4.1-1. Since the UL has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC. Messages to configure the appropriate uplink modulation in section 6.2.1.2.4.3.
3. Send continuously uplink power control "up" commands in every uplink scheduling information to the UE; allow at least [TBD msec] to ensure that the UE transmits at its maximum output power.

4. Measure UE EIRP in the Tx beam peak direction in the channel bandwidth of the radio access mode according to the test configuration. Repeat EIRP measurements for all directions in the sphere according to EIRP measurement procedure defined in Annex K. After a rotation, allow TBD ms for UE to find the best beam to use. The measuring duration is one active uplink subframe. EIRP is calculated considering both polarizations, theta and phi.

5. Calculate a cumulative distribution function for the measured EIRP values.

6.2.1.2.4.3 Message contents

Message contents are according to TS 38.508-1 [10] subclause 4.6.

6.2.1.2.5 Test requirement

The defined %-tile EIRP in measurement distribution derived in step 5 shall exceed the values specified in Table 6.2.1.2.5-1 to Table 6.2.1.2.5-4.

Table 6.2.1.2.5-1: UE spherical coverage for power class 1

Operating band	Min EIRP at 85%-tile CDF (dBm)
n257	32.0-TT
n258	32.0-TT
n260	30.0-TT
n261	32.0-TT

Table 6.2.1.2.5-2: UE spherical coverage for power class 2

Operating band	Min EIRP at 60%-tile CDF (dBm)
n257	18.0-TT
n258	18.0-TT
n260	
n261	18.0-TT

Table 6.2.1.2.5-3: UE spherical coverage for power class 3

Operating band	Min EIRP at 50t%-tile CDF (dBm)
n257	11.5-TT
n258	11.5-TT
n260	8-TT
n261	11.5-TT

Table 6.2.1.2.5-4: UE spherical coverage for power class 4

Operating band	Min EIRP at 20%-tile CDF (dBm)
n257	25
n258	25
n260	19
n261	25

6.2.2 UE maximum output power reduction

FFS

6.2.3 UE maximum output power with additional requirements

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

- Measurement Uncertainties and Test Tolerances are FFS.
- Test point analysis is missing in TR 38.905

- The procedure to ensure UE is at maximum output power is TBD.
- Stand alone message contents in TS 38.508-1[10] subclause 4.6 is FFS

6.2.3.1 Test purpose

6.2.3.2 Test applicability

This test case applies to all types of NR UE release 15 and forward.

6.2.3.3 Minimum conformance requirements

6.2.3.3.1 General

Additional emission requirements can be signalled by the network with network signalling value indicated by the field *additionalSpectrumEmission.* To meet these additional requirements, additional maximum power reduction (A-MPR) is allowed for the maximum output power as specified in subclause 6.2.1.1.3. Unless stated otherwise, an A-MPR of 0 dB shall be used.

Table 6.2.3.3.1-1 specifies the additional requirements and allowed A-MPR with corresponding network signalling label and operating band. The mapping between network signalling labels and the *additionalSpectrumEmission* IE defined in TS 38.331 [19] is specified in Table 6.2.3.3.1-1A. Unless otherwise stated, the allowed A-MPR is in addition to the allowed MPR specified in subclause 6.2.2.

Table 6.2.3.3.1-1: Additional maximum power reduction (A-MPR)

Network Signalling value	Requirements (subclause)	NR Band	Channel bandwidth (MHz)	Resources Blocks (N_{RB})	A-MPR (dB)
NS_200					N/A
NS_201	TBD	n258			

Table 6.2.3.3.1-1A: Value of additionalSpectrumEmission

NR Band	Value of additionalSpectrumEmission / NS number							
	0	1	2	3	4	5	6	7
n257	NS_200							
n258	NS_200	NS_201						
n260	NS_200							
n261	NS_200							
NOTE: additionalSpectrumEmission corresponds to an information element of the same name defined in sub-clause 6.3.2 of TS 38.331 [19].								

The normative reference for this requirement is TS 38.101-2 [3] clause 6.2.3.1.

6.2.3.3.2 A-MPR for NS_201

A-MPR requirement for NS_201 is FSS.

6.2.3.4 Test description

6.2.3.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the Subscriber Station (SS) to take with the UE to reach the correct measurement state.

Table 6.2.3.4.1-1: Test configuration table for NS_201

TBD

1. Connection between SS and UE is shown in TS 38.508-1 [10] Annex A, Figure A.3.1.1.1 for TE diagram and section TBD for UE diagram.
2. The parameter settings for the cell are set up according to TS 38.508-1 [10] subclause 4.4.3.
3. Downlink signals are initially set up according to Annex C.0, C.1 and C.3.0, and uplink signals according to Annex G.0, G.1 and G.3.0.
4. The DL and UL Reference Measurement channels are set according to Table TBD.
5. Propagation conditions are set according to Annex B.0.
6. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity *NR* according to TS 38.508-1 [10] clause 4.5. Message contents are defined in clause 6.2.3.4.3

6.2.3.4.2 Test procedure

TBD

6.2.3.4.3 Message contents

Message contents are according to TS 38.508-1 [10] subclause 4.6.

6.2.3.5 Test requirement

TBD

6.2.4 Configured transmitted power

FFS

6.2A Transmit power for CA

6.2A.1 UE maximum output power for CA

FFS

6.2A.2 UE maximum output power reduction for CA

FFS

6.2A.3 UE maximum output power with additional requirements for CA

FFS

6.2A.4 Configured transmitted power for CA

FFS

6.2D Transmit power for UL-MIMO

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

FFS

6.2D.2 UE maximum output power reduction for UL-MIMO

FFS

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

FFS

6.2D.4 Configured transmitted power for UL-MIMO

FFS

6.3 Output power dynamics

6.3.1 Minimum output power

Editor's Note:

- Initial condition is not complete.
- Combination of test frequency, Channel BW, SCS and Test IDTest point is FFS.
- Measurement Uncertainty and Test Tolerances are FFS.

6.3.1.1 Test purpose

To verify the UE's ability to transmit with a broadband output power below the value specified in the test requirement when the power is set to a minimum value.

6.3.1.2 Test applicability

This test case applies to all types of NR UE release 15 and forward.

6.3.1.3 Minimum conformance requirements

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.

6.3.1.3.1 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

6.3.1.3.2 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
NOTE 1: n260 is not applied for power class 2.			

The normative reference for this requirement is TS 38.101-2 [3] clause 6.3.1.

6.3.1.4 Test description

6.3.1.4.1 Initial condition

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in table 5.2-1. All of these configurations shall be tested with applicable test parameters for each combination of test channel bandwidth and sub-carrier spacing, and are shown in table 6.3.1.4.1-1. The details of the uplink reference measurement channels (RMCs) are specified in Annexes A.2. Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2.

Table 6.3.1.4.1-1: Test Configuration Table

FFS

1. Connection between SS and UE is shown in TS 38.508-1 [10] Annex [TBD], Figure [TBD].
2. The parameter settings for the cell are set up according to TS 38.508-1 [10] clause [TBD].
3. Downlink signals are initially set up according to TS 38.508-1 clause [TBD], and uplink signals according to [TBD].
4. The UL Reference Measurement Channel is set according to Table 6.3.1.4.1-1.
5. Propagation conditions are set according to [Annex B.0].
6. Ensure the UE is in State RRC_CONNECTED with generic procedure parameters Connectivity *NR*, Connected without release *On* according to TS 38.508-1 [10] clause 4.5. Message contents are defined in clause 6.3.1.4.3.

6.3.1.4.2 Test procedure

1. Set the UE in the Tx beam peak direction found with a 3D EIRP scan as performed in clause [TBD].
2. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format 0_1 for C_RNTI to schedule the UL RMC according to Table 6.3.1.4.1-1. Since the UE has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC.
3. Send continuously uplink power control "down" commands in every uplink scheduling information to the UE; allow at least 200ms starting from the first TPC command in this step to ensure that the UE transmits at its minimum output power.
4. Measure UE EIRP in the Tx beam peak direction in the channel bandwidth of the radio access mode according to the test configuration, which shall meet the requirements described in Table 6.3.1.5-1 and Table 6.3.1.5-2. EIRP test procedure is defined in [TBD]. The measuring duration is [one active uplink subframe]. EIRP is calculated considering both polarizations, theta and phi. For TDD slots with transient periods are not under test.

6.3.1.4.3 Message contents

Message contents are according to TS 38.508-1 [10] subclause 4.6.

6.3.1.5 Test requirement

The maximum EIRP, derived in step 4 shall not exceed the values specified in Table 6.3.1.5-1 and Table 6.3.1.5-2.

Table 6.3.1.5-1: 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+TT	47.52
	100	4+TT	95.04
	200	4+TT	190.08
	400	4+TT	380.16

Table 6.3.1.5-2: 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+TT	47.52
	100	-13+TT	95.04
	200	-13+TT	190.08
	400	-13+TT	380.16

6.3.2 Transmit OFF power

Editor's note: This test case is not complete. Following aspects are either missing or not yet determined:

- Test applicability and test description are left FFS.

- The testability of this test case is pending further analysis on relaxation of the requirement.

6.3.2.1 Test purpose

To verify that the UE transmit OFF power is lower than the value specified in the test requirement.

6.3.2.2 Test applicability

FFS

6.3.2.3 Minimum conformance requirement

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 6.3.2.3-1 for each operating band supported. The requirement is verified with the test metric of TRP (Link=TX beam peak direction).

Table 6.3.2.3-1: Transmit OFF power

Operating band	Channel bandwidth / Transmit OFF power (dBm) / measurement bandwidth			
	50 MHz	**100 MHz**	**200 MHz**	**400 MHz**
n257, n258, n259,n261	-35	-35	-35	-35
	47.52 MHz	95.04 MHz	190.08 MHz	380.16 MHz

The normative reference for this requirement is TS 38.101-2 [3] clause 6.3.2.

An excess transmit OFF power potentially increases the Rise Over Thermal (RoT) and therefore reduces the cell coverage area for other UEs.

6.3.2.4 Test description

FFS

6.3.2.5 Test requirement

The requirement for the transmit OFF power shall not exceed the values specified in Table 6.3.2.5-1.

Table 6.3.2.5-1: Transmit OFF power

Operating band	Channel bandwidth / Transmit OFF power (dBm) / measurement bandwidth			
	50 MHz	100 MHz	200 MHz	400 MHz
n257, n258, n261	-35+[14.9]	-35+[17.9]	-35+[20.9]	-35+[23.9]
	47.52 MHz	95.04 MHz	190.08 MHz	380.16 MHz
n260	-35+[24.1]	-35+[27.1]	-35+[30.1]	-35+[33.1]
	47.52 MHz	95.04 MHz	190.08 MHz	380.16 MHz
NOTE 1: Core requirement cannot be tested due to testability issue and test requirement includes relaxation to achieve SNR = [10] dB (Minimum requirement + relaxation).				

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)
- between continuous ON-power transmissions when power change or RB hopping is applied.

In case of RB hopping, transition period is shared symmetrically.

Unless otherwise stated the minimum requirements in clause 6.5 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

Editor's Note:

- Combination of test frequency, Channel BW, SCS and Test IDTest point is FFS.
- Measurement Uncertainty and Test Tolerances are FFS.
- Test requirement of ON power is FFS.
- Testability of OFF power needs further study.
- SA message contents are FFS.
- SA generic procedure is FFS.

6.3.3.2.1 Test purpose

To verify that the general ON/OFF time mask meets the requirements given in 6.3.3.2.5.

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.

Transmission of the wrong power increases interference to other channels, or increases transmission errors in the uplink channel.

6.3.3.2.2 Test applicability

This test case applies to all types of NR UE release 15 and forward.

6.3.3.2.3 Minimum conformance requirements

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)

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.

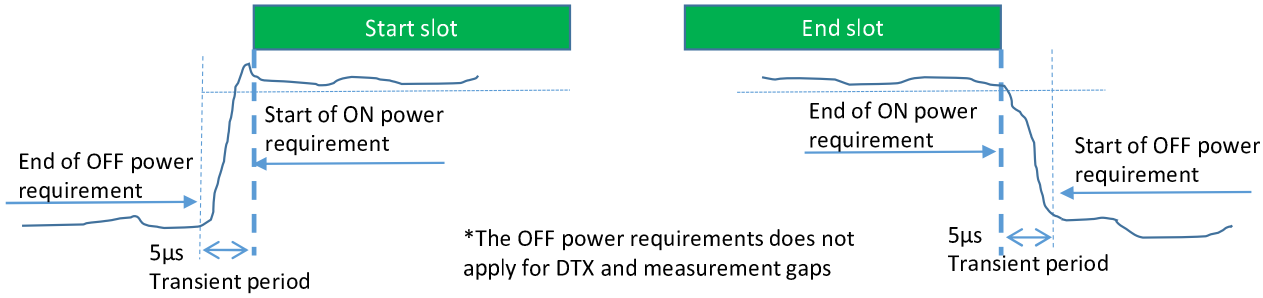

Figure 6.3.3.2.3-1: General ON/OFF time mask for NR UL transmission in FR2

The normative reference for this requirement is TS 38.101-2 [3] clause 6.3.3.2.

6.3.3.2.4 Test description

6.3.3.2.4.1 Initial condition

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in table 5.2-1. All of these configurations shall be tested with applicable test parameters for each combination of test channel bandwidth and sub-carrier spacing, and are shown in table 6.3.3.2.4.1-1. The details of the uplink reference measurement channels (RMCs) are specified in Annexes A.2. Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2.

Table 6.3.3.2.4.1-1: Test Configuration Table

FFS

1. Connection between SS and UE is shown in TS 38.508-1 [10] Annex A Figure A.3.3.1 for TE diagram and Figure A.3.4.1 for UE diagram.
2. The parameter settings for the cell are set up according to TS 38.508-1 [10] subclause 4.4.3.
3. Downlink signals are initially set up according to TS 38.508-1 [10] Annex C.0, C.1 and C.3.0, and uplink signals according to Annex G.0, G.1 and G.3.0.
4. The UL Reference Measurement Channels are set according to Table 6.3.3.2.4.1-1.
5. Propagation conditions are set according to Annex B.0.
6. Ensure the UE is in State RRC_CONNECTED with generic procedure parameters Connectivity *NR*, Connected without release *On* according to TS 38.508-1 [10] clause 4.5. Message contents are defined in clause 6.3.3.2.4.3.

6.3.3.2.4.2 Test procedure

1. Set the UE in the Tx beam peak direction found with a 3D EIRP scan as performed in clause [TBD].
2. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format 0_1 for C_RNTI to schedule the UL RMC according to Table 6.3.3.2.4.1-1. Since the UE has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC.
3. For UE transmission OFF power, measure UE EIRP in the Tx beam peak direction in the channel bandwidth of the radio access mode according to the test configuration, which shall meet the requirements described in Table 6.3.3.2.5-1. EIRP test procedure is defined in Annex K. The period of the measurement shall be the slot prior to the PUSCH transmission, excluding a transient period of 5 µs in the end of the slot and any DL periods. EIRP is calculated considering both polarizations, theta and phi.
4. For UE transmission ON power, measure UE EIRP in the Tx beam peak direction in the channel bandwidth of the radio access mode according to the test configuration, which shall meet the requirements described in Table 6.3.3.2.5-2. EIRP test procedure is defined in Annex K. The period of the measurement shall be one slot with PUSCH transmission. EIRP is calculated considering both polarizations, theta and phi. For TDD slots with transient periods are not under test.
5. For UE transmission OFF power, measure UE EIRP in the Tx beam peak direction in the channel bandwidth of the radio access mode according to the test configuration, which shall meet the requirements described in Table 6.3.3.2.5-1. EIRP test procedure is defined in Annex K. The period of the measurement shall be the slot following the PUSCH transmission, excluding a transient period of 5 µs at the beginning of the slot and any DL periods. EIRP is calculated considering both polarizations, theta and phi.

6.3.3.2.4.3 Message contents

Message contents are according to TS 38.508-1 [10] subclause 4.6 with following exceptions.

Table 6.3.3.2.4.3-1: *PUSCH-ConfigCommon*

Derivation Path: TS 38.508-1[5], Table 4.6.3-90			
Information Element	**Value/remark**	**Comment**	**Condition**
PUSCH-ConfigCommon ::= SEQUENCE {			
p0-NominalWithGrant	-106		
}			

6.3.3.2.5 Test requirement

Table 6.3.3.2.5-1: Test requirement of OFF power of General ON/OFF time mask

	Channel bandwidth / minimum output power / measurement bandwidth			
	50 MHz	**100 MHz**	**200 MHz**	**400 MHz**
Transmit OFF power	≤ -30+TT dBm			
Transmission OFF Measurement bandwidth	47.52 MHz	95.04 MHz	190.08 MHz	380.16 MHz

Table 6.3.3.2.5-2: Test requirement of ON power of General ON/OFF time mask

	SCS [kHz]	**Channel bandwidth / minimum output power / measurement bandwidth**			
		50 MHz	**100 MHz**	**200 MHz**	**400 MHz**

Expected Transmission ON	60	FFS	FFS	FFS	FFS
Measured power for CP-OFDM	120	FFS	FFS	FFS	FFS
Expected Transmission ON	60	FFS	FFS	FFS	FFS
Measured power for DFT-s-OFDM	120	FFS	FFS	FFS	FFS

Table 6.3.3.2.5-3: Test Tolerance for OFF power

FFS

Table 6.3.3.2.5-4: Test Tolerance for ON power

FFS

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

FFS

6.3.3.4 PRACH time mask

Editor's Notes:

- Minimum conformance requirements is not defined (missing in 38.101-1)
- Initial condition is not complete
- Message contents are not complete
- Measurement uncertainty and Test tolerance are not complete
- Test requirements are not complete
- PRACH configuration index is not complete
- The further investigation is essential that how does beamforming affect the initial access procedure
- Testability of OFF power needs further study
- Measurement periods of the slot need to be clarification in the test procedure

6.3.3.4.1 Test purpose

To verify that the PRACH time mask meets the requirements given in 6.3.3.4.5.

The time mask for PRACH time mask defines the ramping time allowed

- between transmit OFF power and transmit ON power symbols (transmit ON/OFF) when transmitting the PRACH

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

Transmission of the wrong power increases interference to other channels, or increases transmission errors in the uplink channel

6.3.3.4.2 Test applicability

This test case applies to all types of NR UE release 15 and forward.

6.3.3.4.3 Minimum conformance requirements

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 PRACH ON power is specified as the mean power over the PRACH measurement period excluding any transient periods as shown in Figure 6.3.3.4.3-1. The measurement period for different PRACH preamble format is specified in Table 6.3.3.4.3-1.

Table 6.3.3.4.3-1: PRACH ON power measurement period

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

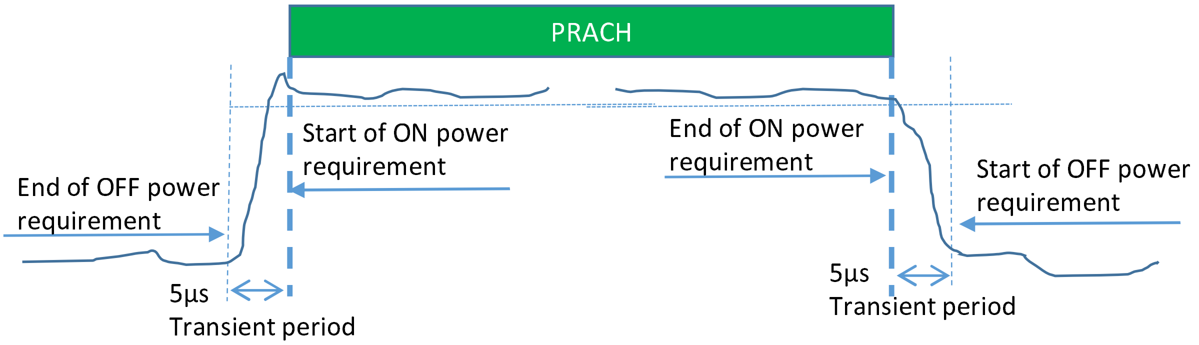

Figure 6.3.3.4.3-1: PRACH ON/OFF time mask

The normative reference for this requirement is TS 38.101-2 [3] clause 6.3.3.4.

6.3.3.4.4 Test description

6.3.3.4.4.1 Initial condition

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in table 5.2-1. All of these configurations shall be tested with applicable test parameters for each combination of test channel bandwidth and sub-carrier spacing, and are shown in table 6.3.3.4.4.1-1. The details of the uplink reference measurement channels (RMCs) are specified in Annexes A.2. Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2.

Table 6.3.3.4.4.1-1: Test Configuration Table

Initial Conditions	
Test Environment as specified in TS 38.508-1 [10] subclause 4.1	TBD
Test Frequencies as specified in TS 38.508-1 [10] subclause 4.3.1	Mid range
Test Channel Bandwidths as specified in TS 38.508-1 [10] subclause 4.3.1	Lowest, Mid, Highest
Test SCS as specified in Table 5.3.5-1	SCS defined in TS 38.211 [8] subclause 6.3.3.2
PRACH preamble format	
PRACH Configuration Index	[0]

1. Connect the SS to the UE antenna connectors as shown in [TBD].
2. The parameter settings for the cell are set up according to [TBD].
3. Downlink signals are initially set up according to [TBD], and uplink signals according to [TBD].

4. Propagation conditions are set according to [TBD].

5. Ensure the UE is in State RRC_CONNECTED with generic procedure parameters Connectivity *NR*, Connected without release *On* according to TS 38.508-1 [10] clause 4.5. Message contents are defined in clause 6.3.3.4.4.3.

6.3.3.4.4.2 Test procedure

1. Set the UE in the Tx beam peak direction found with a 3D EIRP scan as performed in clause [TBD].

2. The SS shall signal a Random Access Preamble ID via a PDCCH order to the UE and initiate a Non-contention based Random Access procedure.

3. The UE shall send the signalled preamble to the SS.

4. FFS

5. For UE transmission ON power, measure UE EIRP in the Tx beam peak direction in the channel bandwidth of the radio access mode according to the test configuration, which shall meet the requirements described in Table [TBD]. EIRP test procedure is defined in [TBD]. The period of the measurement shall be the slot during the PRACH preamble transmission. EIRP is calculated considering both polarizations, theta and phi.

6. FFS

6.3.3.4.4.3 Message contents

Message contents are according to TS 38.508-1 [10] subclause [TBD].

6.3.3.4.5 Test requirement

The requirement for the power measured in steps (3), (4) and (5) of the test procedure shall not exceed the values specified in Table 6.3.3.4.5-1.

Table 6.3.3.4.5-1: PRACH time mask

	Channel bandwidth / Output Power [dBm] / measurement bandwidth			
	50MHz	**100MHz**	**200MHz**	**400MHz**
Transmit OFF power	FFS			
Transmission OFF Measurement bandwidth	FFS	FFS	FFS	FFS
Expected PRACH Transmission ON Measured power	FFS	FFS	FFS	FFS
ON power tolerance FFS	FFS	FFS	FFS	FFS

6.3.3.5 PUCCH time mask

FFS

6.3.3.5.1 Long PUCCH time mask

FFS

6.3.3.5.2 Short PUCCH time mask

FFS

6.3.3.6 SRS time mask

FFS

6.3.3.7 PUSCH-PUCCH and PUSCH-SRS time masks

FFS

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

FFS

6.3.3.9 Transmit power time mask for consecutive short subslot transmissions boundaries

FFS

6.3.4 Power control

6.3.4.1 General

FFS

6.3.4.2 Absolute power tolerance

FFS

6.3.4.3 Relative power tolerance

FFS

6.3.4.4 Aggregate power tolerance

FFS

6.3A Output power dynamics for CA

6.3A.1 Minimum output power for CA

FFS

6.3A.2 Transmit OFF power for CA

FFS

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

FFS

6.3A.4 Power control for CA

6.3A.4.1 General

The requirements in this section apply to a UE when it has at least one of UL or DL configured for CA operation. The requirements on power control accuracy in CA operation apply under normal conditions and are defined as a directional requirement. The requirements are verified in beam locked mode on beam peak direction. The requirements apply for one single PUCCH, PUSCH or SRS transmission of contiguous PRB allocation per configured UL CC with power setting in accordance with Clause 7.1 of [10]

6.3D Output power dynamics for UL-MIMO

6.3D.1 Minimum output power for UL-MIMO

FFS

6.3D.2 Transmit OFF power for UL-MIMO

FFS

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

FFS

6.4 Transmit signal quality

6.4.1 Frequency error

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

- Testing of extreme conditions for FR2 is FFS.
- RAN4 to confirm that RAN5 interpretation of the conformance requirement is correct that an UE passes the frequency error test in FR2 when the requirement is fulfilled for at least one polarization.

6.4.1.1 Test purpose

This test verifies the ability of both, the receiver and the transmitter, to process frequency correctly.

Receiver: to extract the correct frequency from the stimulus signal, offered by the System simulator, under ideal propagation conditions and low level.

Transmitter: to derive the correct modulated carrier frequency from the results, gained by the receiver.

6.4.1.2 Test applicability

This test case applies to all types of NR UE release 15 and forward.

6.4.1.3 Minimum conformance requirements

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).

The normative reference for this requirement is TS 38.101-2 [3] clause 6.4.1

6.4.1.4 Test description

6.4.1.4.1 Initial condition

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1. All of these configurations shall be tested with applicable test parameters for each combination of channel bandwidth and sub-carrier spacing, are shown in table 6.4.1.4.1-1. The details of the uplink and downlink reference measurement channels (RMCs) are specified in Annexes A.2 and A.3. Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2.

Table 6.4.1.4.1-1: Test Configuration Table

Initial Conditions				
Test Environment as specified in TS 38.508-1 [10] subclause 4.1			Normal	
Test Frequencies as specified in TS 38.508-1 [10] subclause 4.3.1			Mid range	
Test Channel Bandwidths as specified in TS 38.508-1 [10] subclause 4.3.1			Highest	
Test SCS as specified in Table 5.3.5-1.			Smallest supported SCS per Channel Bandwidth	
Test Parameters				
	Downlink Configuration		**Uplink Configuration**	
Test ID	**Modulation**	**RB allocation**	**Modulation**	**RB allocation**
1	CP-OFDM QPSK	Full RB (NOTE 1)	DFT-s-OFDM QPSK	REFSENS (NOTE 2)
NOTE 1: Full RB allocation shall be used per each SCS and channel BW as specified in Table 7.3.2.4.1-2 NOTE 2: REFSENS refers to Table 7.3.2.4.1-3 which defines uplink RB configuration and start RB location for each SCS, channel BW and NR band.				

1. Connection between SS and UE is shown in TS 38.508-1 [10] Annex A, Figure A.3.3.1.1 for TE diagram and section A.3.4.1.1 for UE diagram.
2. The parameter settings for the cell are set up according to TS 38.508-1 [10] subclause 4.4.3.
3. Downlink signals are initially set up according to Annex [TBD], and uplink signals according to Annex [TBD]
4. The DL and UL Reference Measurement channels are set according to Table 6.4.1.4.1-1.
5. Propagation conditions are set according to Annex B.0.
6. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity *NR*, Connected without release *On* according to TS 38.508-1 [10] clause 4.5. Message contents are defined in clause 6.4.1.4.3

6.4.1.4.2 Test procedure

1. Set the UE in Tx beam peak direction found with a 3D EIRP scan as performed in clause TBD.
2. SS transmits PDSCH via PDCCH DCI format 1_0 for C_RNTI to transmit the DL RMC according to Table 6.4.1.4.1-1. The SS sends downlink MAC padding bits on the DL RMC.
3. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format 0_1 for C_RNTI to schedule the UL RMC according to Table 6.4.1.4.1-1. Since the UL has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC.
4. Send continuously uplink power control "up" commands to the UE in every uplink scheduling information to the UE so that the UE transmits at P_{UMAX} level for the duration of the test. Allow at least [TBD ms] starting from the first TPC Command for the UE to reach P_{UMAX} level.
5. Lock the beam toward the Tx beam peak direction applying Tx beam lock message TBD.
5. Measure the Frequency Error using Global In-Channel Tx-Test (Annex E) for the θ- and φ-polarization. For TDD slots with transient periods are not under test.

6.4.1.4.3 Message contents

Message contents are according to TS 38.508-1 [10] subclause 4.6 with DFT-s-OFDM condition in Table [4.6.3-n] PUSCH-Config and with the exceptions in subclause 7.3.2.4.3 and Table 7.3.2.5-3.

6.4.1.5 Test requirement

The *n* frequency error Δf results for the θ-polarization or the *n* frequency error Δf results for the φ-polarization must fulfil the test requirement:

$$|\Delta f| \leq (0.1 \text{ PPM} + [0.005] \text{ PPM}),$$

where

$$n = \begin{cases} 30, \text{ for } 60 \text{ kHz SCS} \\ 60, \text{ for } 120 \text{ kHz SCS} \end{cases}.$$

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 Annex E.

All the requirements in 6.4.2 are defined as directional requirement. The requirements are verified in beam locked mode on beam peak direction, with parameter *maxRank* (as defined in TS 38.331 [19]) set to 1. The requirements are applicable to UL transmission from each configurable antenna port (as defined in TS 38.331 [19]) of UE, enabled one at a time.

6.4.2.1 Error vector magnitude

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

- Measurement Uncertainty and Test Tolerance are FFS.
- 38.101-2 Clause 6.3.4.3: Relative power tolerances are in square brackets.
- Annex on Global In-Channel TX-Test contains TBDs for PRACH.

6.4.2.1.1 Test Purpose

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 6.4.2.4.3 and 6.4.2.5.3. 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 contain an allowable power transient as defined in subclause 6.3.3.3.

6.4.2.1.2 Test applicability

This test case applies to all types of NR UE release 15 and forward.

6.4.2.1.3 Minimum conformance requirements

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 6.4.2.1.3-1 for the parameters defined in Table 6.4.2.1.3-2 or Table 6.4.2.1.3-3 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 6.4.2.1.3-1: Minimum requirements for error vector magnitude

Parameter	Unit	Average EVM level	Reference signal EVM level
Pi/2 BPSK	%	30.0	30.0
QPSK	%	17.5	17.5
16 QAM	%	12.5	12.5
64 QAM	%	8.0	8.0

Table 6.4.2.1.3-2: Parameters for Error Vector Magnitude for power class 1

Parameter	Unit	Level
UE EIRP	dBm	≥ 4
UE EIRP for UL 16QAM	dBm	≥ 7
UE EIRP for UL 64QAM	dBm	≥ 11
Operating conditions		Normal conditions

Table 6.4.2.1.3-3: Parameters for Error Vector Magnitude for power class 2, 3, and 4

Parameter	Unit	Level
UE EIRP	dBm	≥ -13
UE EIRP for UL 16QAM	dBm	≥ -10
UE EIRP for UL 64QAM	dBm	≥ -6
Operating conditions		Normal conditions

The normative reference for this requirement is TS 38.101-2 [3] clause 6.4.2.1.

6.4.2.1.4 Test description

6.4.2.1.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1. All of these configurations shall be tested with applicable test parameters for each combination of channel bandwidth and sub-carrier spacing, are shown in table 6.4.2.1.4.1-1. The details of the uplink reference measurement channels (RMCs) are specified in Annex A.2. Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2.

Table 6.4.2.1.4.1-1: Test Configuration Table for PUSCH

Initial Conditions			
Test Environment as specified in TS 38.508-1 [10] subclause 4.1		Normal	
Test Frequencies as specified in TS 38.508-1 [10] subclause 4.3.1		Low range, Mid range, High range	
Test Channel Bandwidths as specified in TS 38.508-1 [10] subclause 4.3.1		Lowest, Highest	
Test SCS as specified in Table 5.3.5-1		Lowest and highest SCS per Channel Bandwidth	
Test Parameters			
Test ID	**Downlink Configuration**	**Uplink Configuration**	
	N/A	**Modulation**	**RB allocation (NOTE 1)**
1		DFT-s-OFDM PI/2 BPSK	Inner_Full
2		DFT-s-OFDM PI/2 BPSK	Outer_Full
3		DFT-s-OFDM QPSK	Inner_Full
4		DFT-s-OFDM QPSK	Outer_Full
5		DFT-s-OFDM 16 QAM	Inner_Full
6		DFT-s-OFDM 16 QAM	Outer_Full
7		DFT-s-OFDM 64 QAM	Inner_Full
8		DFT-s-OFDM 64 QAM	Outer_Full
9		CP-OFDM QPSK	Inner_Full
10		CP-OFDM QPSK	Outer_Full
11		CP-OFDM 16 QAM	Inner_Full
12		CP-OFDM 16 QAM	Outer_Full
13		CP-OFDM 64 QAM	Inner_Full
14		CP-OFDM 64 QAM	Outer_Full
NOTE 1: The specific configuration of each RB allocation is defined in Table 6.1-1. NOTE 2: Test Channel Bandwidths are checked separately for each NR band, which applicable channel bandwidths are specified in Table 5.3.5-1.			

Table 6.4.2.1.4.1-2: Test Configuration Table for PUCCH

Initial Conditions			
Test Environment as specified in TS 38.508-1 [10] subclause 4.1		Normal	
Test Frequencies as specified in TS 38.508-1 [10] subclause 4.3.1		See Table 6.4.2.1.4.1-1	
Test Channel Bandwidths as specified in TS 38.508-1 [10] subclause 4.3.1		See Table 6.4.2.1.4.1-1	
Test SCS as specified in Table 5.3.5-1		See Table 6.4.2.1.4.1-1	
Test Parameters			
ID	**Downlink Configuration**	**Uplink Configuration**	
	N/A	**Waveform**	**PUCCH format**
1		CP-OFDM	PUCCH format = Format 1a / 1b
2		DFT-s-OFDM	PUCCH format = Format 1a / 1b
NOTE 1: Test Channel Bandwidths are checked separately for each NR band, which applicable channel bandwidths are specified in Table 5.3.5-1.			

Table 6.4.2.1.4.1-3: Test Configuration for PRACH

Initial Conditions		
Test Environment as specified in TS 38.508-1 [10] subclause 4.1	Normal	
Test Frequencies as specified in TS 38.508-1 [10] subclause 4.3.1	See Table 6.4.2.1.4.1-1	
Test Channel Bandwidths as specified in TS 38.508-1 [10] subclause 4.3.1	See Table 6.4.2.1.4.1-1	
Test SCS as specified in Table 5.3.5-1	See Table 6.4.2.1.4.1-1	
PRACH preamble format		
	FDD	TDD
PRACH Configuration Index	17	52
RS EPRE setting for test point 1 (dBm/15kHz)	-71	-65
RS EPRE setting for test point 2 (dBm/15kHz)	-86	-80

1. Connection between SS and UE is shown in TS 38.508-1 [10] Annex A, in Figure A.3.3.1.1 for TE diagram and section A.3.4.1.1 for UE diagram.
2. The parameter settings for the cell are set up according to TS 38.508-1 [10] subclause 4.4.3.
3. Downlink signals are initially set up according to Annex [TBD], and uplink signals according to Annex [TBD].
4. The UL Reference Measurement channels are set according to Table 6.4.2.1.4.1-1.
5. Propagation conditions are set according to Annex B.0.
6. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity *NR*, Connected without release *On* according to TS 38.508-1 [10] clause 4.5. Message contents are defined in clause 6.4.2.1.4.3

6.4.2.1.4.2 Test procedure

Test procedure for PUSCH:

1.1 Set the UE in the Tx beam peak direction found with a 3D EIRP scan as performed in clause [TBD].

1.2 SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format 0_1 for C_RNTI to schedule the UL RMC according to Table 6.4.2.1.4.1-1. Since the UE has no payload data to send, the UE transmits uplink MAC padding bits on the UL RMC.

1.3 Send continuously uplink power control "up" commands in the uplink scheduling information to the UE until the UE transmits at [P_{UMAX} level]. Allow at least [TBD ms] starting from the first TPC command in this step for the UE to reach [P_{UMAX} level].

1.4 Ensure the UE beam towards the SS is locked using ACTIVATE BEAMLOCK for TxRx according to TS 38.508-1 [10] clause 4.5.

1.5 Measure the EVM_θ, EVM_φ, $\overline{EVM}_{DMRS,\theta}$ and $\overline{EVM}_{DMRS,\varphi}$ using Global In-Channel Tx-Test (Annex E) for the θ- and φ-polarizations, respectively. Calculate $\overline{EVM}_{DMRS} = \min\left(\overline{EVM}_{DMRS,\theta}, \overline{EVM}_{DMRS,\varphi}\right)$ and $EVM = \min(EVM_\theta, EVM_\varphi)$.

1.6 Ensure the UE beam towards the SS is unlocked using DEACTIVATE BEAMLOCK according to TS 38.508-1 [10] clause 4.5.

1.7 Send the appropriate TPC commands in the uplink scheduling information to the UE until UE EIRP is in the range $P_{req} + P_W \pm P_W$, where P_{req} is the power level specified in Tables 6.4.2.1.4.2-1 and 6.4.2.1.4.2-2 according to the modulation and power class. P_W is the power window according to Table 6.4.2.1.4.2-3 for the carrier frequency f and the channel bandwidth BW.

1.8 Ensure the UE beam towards the SS is locked using ACTIVATE BEAMLOCK for TxRx according to TS 38.508-1 [10] clause 4.5.

1.9 Measure the EVM_θ, EVM_φ, $\overline{EVM}_{DMRS,\theta}$ and $\overline{EVM}_{DMRS,\varphi}$ using Global In-Channel Tx-Test (Annex E) for the θ- and φ-polarizations, respectively. Calculate $\overline{EVM}_{DMRS} = \min\left(\overline{EVM}_{DMRS,\theta}, \overline{EVM}_{DMRS,\varphi}\right)$ and $EVM = \min(EVM_\theta, EVM_\varphi)$.

1.10 Ensure the UE beam towards the SS is unlocked using DEACTIVATE BEAMLOCK according to TS 38.508-1 [10] clause 4.5.

NOTE1: When switching to DFT-s-OFDM waveform, as specified in the test configuration table 6.4.2.1.4.1-1, send an NR RRCReconfiguration message according to TS 38.508-1 [10] clause 4.6.3 Table 4.6.3-89 PUSCH-Config without CP-OFDM condition. When switching to CP-OFDM waveform, send an NR RRCReconfiguration message with CP-OFDM condition.

Table 6.4.2.1.4.2-1: 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

Table 6.4.2.1.4.2-2: 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

Table 6.4.2.1.4.2-3: Power Window (dB) for EVM PUSCH and PUCCH

TBD

Test procedure for PUCCH:

2.1 Set the UE in the Tx beam peak direction found with a 3D EIRP scan as performed in clause [TBD].

2.2 PUCCH is set according to Table 6.4.2.1.4.1-2.

2.3 SS transmits PDSCH via PDCCH DCI format 0_1 for C_RNTI to transmit the DL RMC according to Table 6.4.2.1.4.1-2. The SS sends downlink MAC padding bits on the DL RMC. The transmission of PDSCH will make the UE send uplink ACK/NACK using PUCCH. There is no PUSCH transmission.

2.4 SS send appropriate TPC commands for PUCCH to the UE until the UE transmit PUCCH at [P_{UMAX} level]. Allow at least [TBDms] starting from the first TPC command in this step for the UE to reach [P_{UMAX} level].

2.5 Ensure the UE beam towards the SS is locked using ACTIVATE BEAMLOCK for TxRx according to TS 38.508-1 [10] clause 4.5.

2.6 Measure PUCCH EVM_θ and PUCCH EVM_φ using Global In-Channel Tx-Test (Annex E). Calculate $\text{PUCCH EVM} = \min(\text{PUCCH EVM}_\theta, \text{PUCCH EVM}_\varphi)$.

2.7 Ensure the UE beam towards the SS is unlocked using DEACTIVATE BEAMLOCK according to TS 38.508-1 [10] clause 4.5.

2.8 Send the appropriate TPC commands in the uplink scheduling information to the UE until UE EIRP is in the range $P_{req} + P_W \pm P_W$, where P_{req} is the power level specified in Tables 6.4.2.1.4.2-1 and 6.4.2.1.4.2-2 according to the modulation and power class. P_W is the power window according to Table 6.4.2.1.4.2-3 for the carrier frequency f and the channel bandwidth BW.

2.9 Ensure the UE beam towards the SS is locked using ACTIVATE BEAMLOCK for TxRx according to TS 38.508-1 [10] clause 4.5.

2.10 Measure PUCCH EVM_θ and PUCCH EVM_φ using Global In-Channel Tx-Test (Annex E). Calculate $\text{PUCCH EVM} = \min(\text{PUCCH EVM}_\theta, \text{PUCCH EVM}_\varphi)$.

2.11 Ensure the UE beam towards the SS is unlocked using DEACTIVATE BEAMLOCK according to TS 38.508-1 [10] clause 4.5.

NOTE1: When switching to DFT-s-OFDM waveform, as specified in the test configuration table 6.4.2.1.4.1-2, send an NR RRCReconfiguration message according to TS 38.508-1 [10] clause 4.6.3 Table 4.6.3-89 PUSCH-Config without CP-OFDM condition. When switching to CP-OFDM waveform, send an NR RRCReconfiguration message with CP-OFDM condition.

Test procedure for PRACH:

3.1 Set the UE in the Tx beam peak direction found with a 3D EIRP scan as performed in clause [TBD].

3.2 The SS shall set RS EPRE according to Table 6.4.2.1.4.1-3.

3.3 PRACH is set according to Table 6.4.2.1.4.1-3.

3.4 The SS shall signal a Random Access Preamble ID via a PDCCH order to the UE and initiate a Non-contention based Random Access procedure.

3.5 The UE shall send the signalled preamble to the SS.

3.6 In response to the preamble, the SS shall transmit a random access response not corresponding to the transmitted random access preamble, or send no response.

3.7 The UE shall consider the random access response reception not successful then re-transmit the preamble with the calculated PRACH transmission power.

3.8 Repeat step 5 and 6 until the SS collect enough PRACH preambles ([2] preambles for format 0 and [10] preambles for format 4). Measure the EVM_θ and EVM_φ in PRACH channel using Global In-Channel Tx-Test (Annex E). Calculate $\text{EVM} = \min(\text{EVM}_\theta, \text{EVM}_\varphi)$.

6.4.2.1.4.3 Message contents

Message contents are according to TS 38.508-1 [10] subclause 4.6.

6.4.2.1.5 Test requirement

The PUSCH EVM, derived in Annex E.4.2, shall not exceed the values in Table 6.4.2.1.5-1.

The PUSCH $\overline{EVM}_{DMRS}$, derived in Annex E.4.6.2, shall not exceed the values in Table 6.4.2.1.5-1 when embedded with data symbols of the respective modulation scheme.

The PUCCH EVM derived in Annex E.5.9.2 shall not exceed the values the values in Table 6.4.2.1.5-1.

The PRACH EVM derived in Annex E.6.9.2 shall not exceed the values the values in Table 6.4.2.1.5-1.

Table 6.4.2.1.5-1: Test requirements for Error Vector Magnitude

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

6.4.2.2 Carrier leakage

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

- Measurement Uncertainty and Test Tolerance are FFS.

- 38.101-2 Clause 6.3.4.3: Relative power tolerances are in square brackets.
- 38.101-2 Requirements for power class 4 are FFS.
- UL RMC is missing in TS 38.101-2

6.4.2.2.1 Test purpose

Carrier leakage expresses itself as unmodulated sine wave with the carrier frequency. It is an interference of approximately constant amplitude and independent of the amplitude of the wanted signal. Carrier leakage interferes with the sub carriers at its position (if allocated), especially, when their amplitude is small.

The purpose of this test is to exercise the UE transmitter to verify its modulation quality in terms of carrier leakage.

6.4.2.2.2 Test applicability

This test case applies to all types of NR UE release 15 and forward.

6.4.2.2.3 Minimum conformance requirements

Carrier leakage is an additive sinusoid waveform. The carrier leakage requirement is defined for each component carrier. The measurement interval is one slot in the time domain. The relative carrier leakage power is a power ratio of the additive sinusoid waveform to the power in the modulated waveform.

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

When carrier leakage is contained inside the spectrum confined within the configured UL and DL CCs, the relative carrier leakage power shall not exceed the values specified in Table 6.4.2.2.3-1 for power class 1 UEs.

Table 6.4.2.2.3-1: Minimum requirements for relative carrier leakage power for power class 1

Parameters	Relative Limit (dBc)
EIRP > 17 dBm	-25
4 dBm ≤ EIRP ≤ 17 dBm	-20

When carrier leakage is contained inside the spectrum occupied by the configured UL CCs and DL CCs, the relative carrier leakage power shall not exceed the values specified in Table 6.4.2.2.3-2 for power class 2.

Table 6.4.2.2.3-2: Minimum requirements for relative carrier leakage power for power class 2

Parameters	Relative Limit (dBc)
EIRP > 6 dBm	-25
-13 dBm ≤ EIRP ≤ 6 dBm	-20

When carrier leakage is contained inside the spectrum occupied by the configured UL CCs and DL CCs, the relative carrier leakage power shall not exceed the values specified in Table 6.4.2.2.3-3 for power class 3 UEs.

Table 6.4.2.2.3-3: Minimum requirements for relative carrier leakage power for power class 3

Parameters	Relative Limit (dBc)
EIRP > 0 dBm	-25
-13 dBm ≤ EIRP ≤ 0 dBm	-20

When carrier leakage is contained inside the spectrum occupied by the configured UL CCs and DL CCs, the relative carrier leakage power shall not exceed the values specified in Table 6.4.2.2.3-4 for power class 4.

Table 6.4.2.2.3-4: Minimum requirements for relative carrier leakage power for power class 4

Parameters	Relative Limit (dBc)
EIRP > 11 dBm	-25
-13 dBm ≤ EIRP ≤11 dBm	-20

The normative reference for this requirement is TS 38.101-2[3] clause 6.4.2.2.

6.4.2.2.4 Test description

6.4.2.2.4.1 Initial condition

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1. All of these configurations shall be tested with applicable test parameters for each combination of channel bandwidth and sub-carrier spacing, are shown in table 6.4.2.2.4.1-1. The details of the uplink reference measurement channels (RMCs) are specified in Annexes A.2. Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2.

Table 6.4.2.2.4.1-1: Test Configuration

Initial Conditions			
Test Environment as specified in TS 38.508-1 [10] subclause 4.1		Normal	
Test Frequencies as specified in TS 38.508-1 [10] subclause 4.3.1		Low range, Mid range, High range	
Test Channel Bandwidths as specified in TS 38.508-1 [10] subclause 4.3.1		Mid	
Test SCS as specified in Table 5.3.5-1		Smallest supported SCS per Channel Bandwidth	
Test Parameters			
Test ID	**Downlink Configuration**	**Uplink Configuration**	
	N/A	**Modulation**	**RB allocation (NOTE 1, 3)**
1		DFT-s-OFDM QPSK	Inner_16RB_Left
NOTE 1: The specific configuration of each RB allocation is defined in Table 6.1-1. NOTE 2: Test Channel Bandwidths are checked separately for each NR band, which applicable channel bandwidths are specified in Table 5.3.5-1. NOTE 3: When the signalled DC carrier position is at Inner_15RB_Left, use Inner_15RB_Right for UL RB allocation.			

1. Connection between SS and UE is shown in TS 38.508-1 [10] Annex A, in Figure A.3.3.1.1 for TE diagram and section A.3.4.1.1 for UE diagram.
2. The parameter settings for the cell are set up according to TS 38.508-1 [10] subclause 4.4.3.
3. Downlink signals are initially set up according to Annex [TBD], and uplink signals according to Annex [TBD].
4. The UL Reference Measurement channels are set according to Table 6.4.2.2.4.1-1.
5. Propagation conditions are set according to Annex B.0.
6. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity *NR*, Connected without release *On* according to TS 38.508-1 [10] clause 4.5. Message contents are defined in clause 6.4.2.2.4.3.

6.4.2.2.4.2 Test procedure

1. Set the UE in the Tx beam peak direction found with a 3D EIRP scan as performed in clause [TBD].

2. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format 0_1 for C_RNTI to schedule the UL RMC according to Table 6.4.2.2.4.1-1. Since the UE has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC.

3. Send the appropriate TPC commands in the uplink scheduling information to the UE until UE EIRP is in the range $P_{req} + P_W \pm P_W$, where P_{req} is the power level specified in Tables 6.4.2.2.4.2-1 according to the power class. P_W is the power window according to Table 6.4.2.1.4.2-3 for the carrier frequency f and the channel bandwidth BW.

4. Ensure the UE beam towards the SS is locked using ACTIVATE BEAMLOCK for Tx and Rx according to TS 38.508-1 [10] clause 4.5.

5. Measure carrier leakage using Global In-Channel Tx-Test (Annex E) for the θ- and ϕ-polarization. For TDD slots with transient periods are not under test.

6. Ensure the UE beam towards the SS is unlocked using DEACTIVATE BEAMLOCK according to TS 38.508-1 [10] clause 4.5.

7. Send the appropriate TPC commands in the uplink scheduling information to the UE until UE EIRP is in the range $P_{req} + P_W \pm P_W$, where P_{req} is the power level specified in Tables 6.4.2.2.4.2-1 according to the power class. P_W is the power window according to Table 6.4.2.1.4.2-3 for the carrier frequency f and the channel bandwidth BW.

8. Ensure the UE beam towards the SS is locked using ACTIVATE BEAMLOCK for Tx and Rx according to TS 38.508-1 [10] clause 4.5.

9. Measure carrier leakage using Global In-Channel Tx-Test (Annex E) for the θ- and ϕ-polarization. For TDD slots with transient periods are not under test.

10. Ensure the UE beam towards the SS is unlocked using DEACTIVATE BEAMLOCK according to TS 38.508-1 [10] clause 4.5.

Table 6.4.2.2.4.2-1: UE EIRP P_{req} (dBm) for carrier leakage

Power Class	P_{req} (dBm) for step 3	P_{req} (dBm) for step 7
Power Class 1	17	4
Power Class 3	0	-13

Table 6.4.2.2.4.2-2: Power Window (dB) for carrier leakage

TBD

6.4.2.2.4.3 Message contents

Message contents are according to TS 38.508-1 [10] subclause 4.6.

6.4.2.2.5 Test requirement

For each of the *n* carrier leakage results derived in Annex E.3.1 for θ- and φ-polarization the total value is calculated according to

$$\mathrm{CarrLeak_{Total}} = 10\log_{10}\left(10^{\mathrm{CarrLeak}_\theta/10} + 10^{\mathrm{CarrLeak}_\varphi/10}\right), \text{ where}$$

$$n = \begin{cases} 30, \text{ for 60 kHz SCS} \\ 60, \text{ for 120 kHz SCS} \end{cases}.$$

Each of the *n* total carrier leakage results $\mathrm{CarrLeak_{Total}}$ shall not exceed the values in table 6.4.2.2.5-1 for power class 1 and table 6.4.2.2.5-3 for power class 3. Allocated RBs are not under test.

Table 6.4.2.2.5-1: Test requirements for relative carrier leakage power for power class 1

LO Leakage	Parameters UE EIRP	Relative limit (dBc)
	17 + P_W dBm ± P_W dB	-25 + TT
	4 + P_W dBm ± P_W dB	-20 + TT
NOTE 1: 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 2: 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 3: N_{RB} is the Transmission Bandwidth Configuration (see Figure 5.3.3-1). NOTE 4: All power levels are UE EIRP in beam peak direction. NOTE 5: P_W is the power window according to Table 6.4.2.2.4.2-2 for the carrier frequency f and the channel bandwidth BW.		

Table 6.4.2.2.5-3: Test requirements for relative carrier Leakage Power for power class 3

LO Leakage	Parameters UE EIRP	Relative limit (dBc)
	6 + P_W dBm ± P_W dB	-25 + TT
	-13 + P_W dBm ± P_W dB	-20 + TT
NOTE 1: 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 2: 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 3: N_{RB} is the Transmission Bandwidth Configuration (see Figure 5.3.3-1). NOTE 4: All power levels are UE EIRP in beam peak direction. NOTE 5: P_W is the power window according to Table 6.4.2.2.4.2-2 for the carrier frequency f and the channel bandwidth BW.		

Table 6.4.2.2.5-3: Test requirements for relative carrier Leakage Power for power class 3

LO Leakage	Parameters UE EIRP	Relative limit (dBc)
	0 + P_W dBm ± P_W dB	-25 + TT
	-13 + P_W dBm ± P_W dB	-20 + TT
NOTE 1: 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 2: 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 3: N_{RB} is the Transmission Bandwidth Configuration (see Figure 5.3.3-1). NOTE 4: All power levels are UE EIRP in beam peak direction. NOTE 5: P_W is the power window according to Table 6.4.2.2.4.2-2 for the carrier frequency f and the channel bandwidth BW.		

6.4.2.3 In-band emissions

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

- SA message contents in TS 38.508-1 subclause 4.6 is FFS.
- SA generic procedures with condition NR in TS 38.508-1 is FFS.
- Measurement Uncertainty and Test Tolerance are FFS.
- UL RMC is missing in TS 38.101-2
- 38.101-2 Clause 6.3.4.3: Relative power tolerances are in square brackets.

6.4.2.3.1 Test purpose

The in-band emissions are a measure of the interference falling into the non-allocated resources blocks.

The purpose of this test is to exercise the UE transmitter to verify its modulation quality in terms of in-band emissions.

6.4.2.3.2 Test applicability

This test case applies to all types of NR UE release 15 and forward.

6.4.2.3.3 Minimum conformance requirements

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

The relative in-band emission shall not exceed the values specified in Table 6.4.2.3.3-1 for power class 1 UEs.

Table 6.4.2.3.3-1: Requirements for in-band emissions for power class 1

Parameter description	Unit	Limit (NOTE 1)		Applicable Frequencies
General	dB	$max\left[\begin{array}{c} -25 - 10.\log_{10}\left(\frac{N_{RB}}{L_{CRB}}\right), \\ 20.\log_{10}(EVM) - 5.\frac{(\lvert\Delta_{RB}\rvert-1)}{L_{CRB}}, \\ -55.1dBm - P_{RB} \end{array}\right]$		Any non-allocated (NOTE 2)
IQ Image	dB	-25	Output power > 27 dBm	Image frequencies (NOTES 2, 3)
		-20	Output power ≤ 27 dBm	
Carrier leakage	dBc	-25	Output power > 17 dBm	Carrier frequency (NOTES 4, 5)
		-20	4 dBm ≤ Output power ≤ 17 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.

The relative in-band emission shall not exceed the values specified in Table 6.4.2.3.3-2 for power class 2.

Table 6.4.2.3.3-2: Requirements for in-band emissions for power class 2

Parameter description	Unit	Limit (NOTE 1)		Applicable Frequencies
General	dB	$max\left[\begin{array}{c} -25 - 10.\log_{10}\left(\frac{N_{RB}}{L_{CRB}}\right), \\ 20.\log_{10}(EVM) - 5.\frac{(\lvert\Delta_{RB}\rvert-1)}{L_{CRB}}, \\ -55.1dBm - P_{RB} \end{array}\right]$		Any non-allocated (NOTE 2)
IQ Image	dB	-25	Output power > 27 dBm	Image frequencies (NOTES 2, 3)
		-20	Output power ≤ 27 dBm	
Carrier leakage	dBc	-25	Output power > 17 dBm	Carrier frequency (NOTES 4, 5)
		-20	4 dBm ≤ Output power ≤ 17 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.

The relative in-band emission shall not exceed the values specified in Table 6.4.2.3.3-3 for power class 3 UEs.

Table 6.4.2.3.3-3: Requirements for in-band emissions for power class 3

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.

The normative reference for this requirement is TS 38.101-2 [3] clause 6.4.2.3.

6.4.2.3.4 Test description

6.4.2.3.4.1 Initial condition

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1. All of these configurations shall be tested with applicable test parameters for each combination of channel bandwidth and sub-carrier spacing, are shown in table 6.4.2.3.4.1-1. The details of the uplink reference measurement channels (RMCs) are specified in Annex A.2. Configurations of PDSCH and PDCCH before measurement are specified in Annex [TBD].

Table 6.4.2.3.4.1-1: Test Configuration Table for PUSCH

Initial Conditions			
Test Environment as specified in TS 38.508-1 [10] subclause 4.1		Normal	
Test Frequencies as specified in TS 38.508-1 [10] subclause 4.3.1		Low range, Mid range, High range	
Test Channel Bandwidths as specified in TS 38.508-1 [10] subclause 4.3.1		Lowest, Mid, Highest	
Test SCS as specified in Table 5.3.5-1		Smallest supported SCS per Channel Bandwidth	
Test Parameters			
Test ID	**Downlink Configuration**	**Uplink Configuration**	
	N/A	**Modulation**	**RB allocation (NOTE 1)**
1		DFT-s-OFDM PI/2 BPSK	Inner_16RB_Left
2		DFT-s-OFDM PI/2 BPSK	Inner_16RB_Right
3		CP-OFDM QPSK	Inner_16RB_Left
4		CP-OFDM QPSK	Inner_16RB_Right
NOTE 1: The specific configuration of each RB allocation is defined in Table 6.1-1. NOTE 2: Test Channel Bandwidths are checked separately for each NR band, which applicable channel bandwidths are specified in Table 5.3.5-1.			

Table 6.4.2.3.4.1-2: Test Configuration Table for PUCCH

Initial Conditions			
Test Environment as specified in TS 38.508-1 [10] subclause 4.1		See Table 6.4.2.3.4.1-1	
Test Frequencies as specified in TS 38.508-1 [10] subclause 4.3.1		See Table 6.4.2.3.4.1-1	
Test Channel Bandwidths as specified in TS 38.508-1 [10] subclause 4.3.1		See Table 6.4.2.3.4.1-1	
Test SCS as specified in Table 5.3.5-1		See Table 6.4.2.3.4.1-1	
Test Parameters			
ID	**Downlink Configuration**	**Uplink Configuration**	
	N/A	**Waveform**	**PUCCH format**
1		CP-OFDM	PUCCH format = Format 1a / 1b
2		DFT-s-OFDM	PUCCH format = Format 1a / 1b
NOTE 1: Test Channel Bandwidths are checked separately for each NR band, which applicable channel bandwidths are specified in Table 5.3.5-1.			

1. Connection between SS and UE is shown in TS 38.508-1 [10] Annex A, in Figure A.3.3.1.1 for TE diagram and section A.3.4.1.1 for UE diagram.

2. The parameter settings for the cell are set up according to TS 38.508-1 [10] subclause 4.4.3.

3. Downlink signals are initially set up according to Annex [TBD], and uplink signals according to Annex [TBD].

4. The UL Reference Measurement channels are set according to Table 6.4.2.3.4.1-1.

5. Propagation conditions are set according to Annex B.0.

6. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity *NR* according to TS 38.508-1 [10] clause 4.5. Message contents are defined in clause 6.4.2.3.4.3

6.4.2.3.4.2 Test procedure

Test procedure for PUSCH:

1.1 Set the UE in the Tx beam peak direction found with a 3D EIRP scan as performed in clause [TBD].

1.2 SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format [1_0] for C_RNTI to schedule the UL RMC according to Table 6.4.2.3.4.1-1. Since the UE has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC.

1.3 Send the appropriate TPC commands in the uplink scheduling information to the UE until UE output power is $P_{req} + P_W \pm P_{W,}$ where P_{req} is the power level specified in Tables 6.4.2.3.4.2-1 according to the power class with power ID = 1. P_W is the power window according to Table 6.4.2.3.4.2-2 for the carrier frequency f and the channel bandwidth BW.

1.4 Ensure the UE beam towards the SS is locked using ACTIVATE BEAMLOCK for TxRx according to TS 38.508-1 [10] clause 4.5.

1.5 Measure In-band emission IE_θ, IE_φ using Global In-Channel Tx-Test (Annex E) for the θ- and φ-polarizations, respectively. Calculate $IE = IE_\theta + IE_\varphi$, where the calculation is based on linear power ratios.

1.6 Ensure the UE beam towards the SS is unlocked using DEACTIVATE BEAMLOCK according to TS 38.508-1 [10] clause 4.5.

1.7 Repeat steps 1.3 through 1.6 until In-band emissions have been measured for all power IDs in Table 6.4.2.1.4.2-1.

NOTE1: When switching to DFT-s-OFDM waveform, as specified in the test configuration table 6.4.2.1.4.1-1, send an NR RRCReconfiguration message according to TS 38.508-1 [10] clause 4.6.3 Table 4.6.3-89 PUSCH-Config without CP-OFDM condition. When switching to CP-OFDM waveform, send an NR RRCReconfiguration message with CP-OFDM condition.

Table 6.4.2.1.4.2-1: Parameters for In-band emissions

Power ID	Unit	Level for power class 1	Level for power class 2	Level for power class 3
1	dBm	27	27	10
2	dBm	17	17	0
3	dBm	4	4	-13

Table 6.4.2.1.4.2-2: Power Window (dB) for In-band emissions PUSCH and PUCCH

TBD

Test procedure for PUCCH:

2.1 Set the UE in the Tx beam peak direction found with a 3D EIRP scan as performed in clause [TBD].

2.2 PUCCH is set according to Table 6.4.2.3.4.1-2. SS transmits PDSCH via PDCCH DCI format [1A] for C_RNTI to transmit the DL RMC according to Table 6.4.2.3.4.1-2. The SS sends downlink MAC padding bits on the DL RMC. The transmission of PDSCH will make the UE send uplink ACK/NACK using PUCCH.

2.3 Send the appropriate TPC commands in the uplink scheduling information for PUCCH to the UE until UE output power is $P_{req} + P_W \pm P_{W,}$ where P_{req} is the power level specified in Tables 6.4.2.3.4.2-1 according to the power class with power ID = 1. P_W is the power window according to Table 6.4.2.3.4.2-2 for the carrier frequency f and the channel bandwidth BW.

2.4 Ensure the UE beam towards the SS is locked using ACTIVATE BEAMLOCK for TxRx according to TS 38.508-1 [10] clause 4.5.

2.5 Measure In-band emission IE_θ, IE_φ using Global In-Channel Tx-Test (Annex E) for the θ- and φ-polarizations, respectively. Calculate $IE = IE_\theta + IE_\varphi$, where the calculation is based on linear power ratios.

2.6 Ensure the UE beam towards the SS is unlocked using DEACTIVATE BEAMLOCK according to TS 38.508-1 [10] clause 4.5.

2.7 Repeat steps 2.3 through 2.6 until In-band emissions have been measured for all power IDs in Table 6.4.2.1.4.2-1.

6.4.2.3.4.3 Message contents

Message contents are according to TS 38.508-1 [10] subclause 4.6.

6.4.2.3.5 Test requirement

Each of the *n* In-band emissions results, derived in Annex E.4.3 shall not exceed the corresponding values in Table 6.4.2.3.5-1 for power class 1 UEs.

Table 6.4.2.3.5-1: Requirements for in-band emissions for power class 1

Parameter description	**Unit**	**Limit (NOTE 1)**		**Applicable Frequencies**
General	dB	$max\begin{bmatrix} -25 - 10.\log_{10}\left(\frac{N_{RB}}{L_{CRB}}\right), \\ 20.\log_{10}(EVM) - 5.\frac{(\lvert\Delta_{RB}\rvert-1)}{L_{CRB}}, \\ -55.1dBm - P_{RB} \end{bmatrix}$ + TT		Any non-allocated (NOTE 2)
IQ Image	dB	-25+TT	Output power > 27 dBm	Image frequencies (NOTES 2, 3)
		-20+TT	Output power ≤ 27 dBm	
Carrier leakage	dBc	-25+TT	Output power > 17 dBm	Carrier frequency (NOTES 4, 5)
		-20+TT	4 dBm ≤ Output power ≤ 17 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.

Each of the *n* In-band emissions results, derived in Annex E.4.3 shall not exceed the corresponding values in Table 6.4.2.3.5-2 for power class 2 UEs.

Table 6.4.2.3.5-2: Requirements for in-band emissions for power class 2

Parameter description	**Unit**	**Limit (NOTE 1)**		**Applicable Frequencies**
General	dB	$max\begin{bmatrix} -25 - 10.\log_{10}\left(\frac{N_{RB}}{L_{CRB}}\right), \\ 20.\log_{10}(EVM) - 5.\frac{(\lvert\Delta_{RB}\rvert-1)}{L_{CRB}}, \\ -55.1dBm - P_{RB} \end{bmatrix}$ + TT		Any non-allocated (NOTE 2)
IQ Image	dB	-25 + TT	Output power > 27 dBm	Image frequencies (NOTES 2, 3)
		-20 + TT	Output power ≤ 27 dBm	
Carrier leakage	dBc	-25 + TT	Output power > 17 dBm	Carrier frequency (NOTES 4, 5)
		-20 + TT	4 dBm ≤ Output power ≤ 17 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.

Each of the *n* In-band emissions results, derived in Annex E.4.3 shall not exceed the corresponding values in Table 6.4.2.3.5-3 for power class 3 UEs.

Table 6.4.2.3.5-3: Requirements for in-band emissions for power class 3

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

6.4.2.4 EVM equalizer spectrum flatness

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

- SA message contents in TS 38.508-1 subclause 4.6 is FFS.
- SA generic procedures with condition NR in TS 38.508-1 is FFS.
- Measurement Uncertainty and Test Tolerance are FFS.
- 38.101-2 Clause 6.3.4.3: Relative power tolerances are in square brackets.

6.4.2.4.1 Test purpose

The zero-forcing equalizer correction applied in the EVM measurement process (as described in Annex E) must meet a spectral flatness requirement for the EVM measurement to be valid. 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, at which the equalizer coefficients are generated by the EVM measurement process. The basic measurement interval is the same as for EVM.

The EVM equalizer spectrum flatness requirement does not limit the correction applied to the signal in the EVM measurement process but for the EVM result to be valid, the equalizer correction that was applied must meet the EVM equalizer spectrum flatness minimum requirements.

6.4.2.4.2 Test applicability

This test case applies to all types of NR UE release 15 and forward.

6.4.2.4.3 Minimum conformance requirements

For BPSK modulation waveforms, the minimum requirements are defined in Clause 6.4.2.5.3.

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 6.4.2.4.3-1 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 6.4.2.4.3-1) 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 6.4.2.4.3-1).

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

Table 6.4.2.4.3-1: 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	

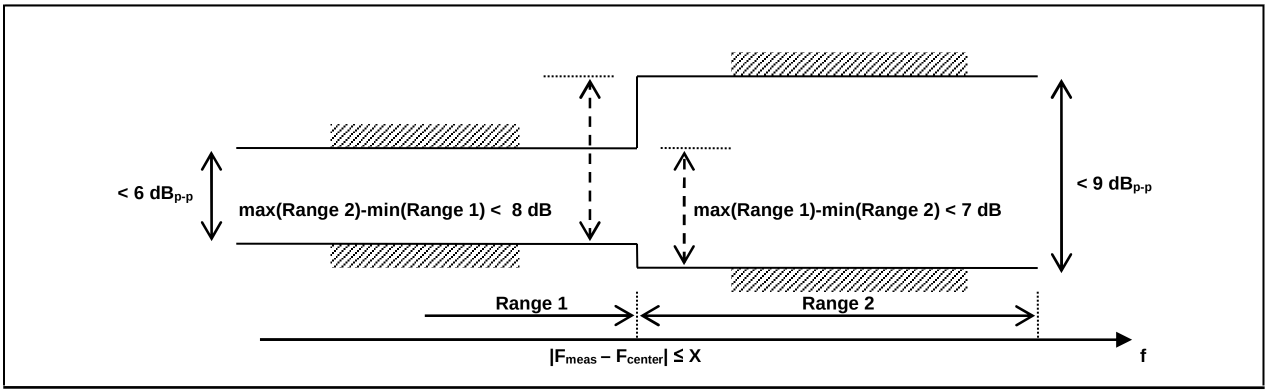

Figure 6.4.2.4.3-1: The limits for EVM equalizer spectral flatness with the maximum allowed variation of the coefficients indicated under normal conditions

The normative reference for this requirement is TS 38.101-2 [3] clause 6.4.2.4.

6.4.2.4.4 Test description

6.4.2.4.4.1 Initial condition

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in Table 5.3.5-1. All of these configurations shall be tested with applicable test parameters for each combination of channel bandwidth and sub-carrier spacing, are shown in table

6.4.2.4.4.1-1. The details of the uplink reference measurement channels (RMCs) are specified in Annex A.2. Configurations of PDSCH and PDCCH before measurement are specified in Annex [TBD].

Table 6.4.2.4.4.1-1: Test Configuration

Initial Conditions			
Test Environment as specified in TS 38.508-1 [10] subclause 4.1		Normal	
Test Frequencies as specified in TS 38.508-1 [10] subclause 4.3.1		Low range, Mid range, High range	
Test Channel Bandwidths as specified in TS 38.508-1 [10] subclause 4.3.1		Lowest, Mid, Highest	
Test SCS as specified in Table 5.3.5-1		Lowest SCS per Channel Bandwidth	
Test Parameters			
Test ID	**Downlink Configuration**	**Uplink Configuration**	
	N/A	**Modulation**	**RB allocation (NOTE 1)**
1		DFT-s-OFDM QPSK	Outer_Full
2		CP-OFDM QPSK	Outer_Full
NOTE 1: The specific configuration of each RB allocation is defined in Table 6.1-1. NOTE 2: Test Channel Bandwidths are checked separately for each NR band, which applicable channel bandwidths are specified in Table 5.3.5-1.			

1. Connection between SS and UE is shown in TS 38.508-1 [10] Annex A, in Figure A.3.1.1.1 for TE diagram and section A.3.4.1.1 for UE diagram.
2. The parameter settings for the cell are set up according to TS 38.508-1 [10] subclause 4.4.3.
3. Downlink signals are initially set up according to Annex [TBD], and uplink signals according to Annex [TBD].
4. The UL Reference Measurement channels are set according to Table 6.4.2.4.4.1-1.
5. Propagation conditions are set according to Annex B.0.
6. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity *NR* according to TS 38.508-1 [10] clause 4.5. Message contents are defined in clause 6.4.2.4.4.3

6.4.2.4.4.2 Test procedure

1 Set the UE in the Tx beam peak direction found with a 3D EIRP scan as performed in clause [TBD].

2. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format [0_1] for C_RNTI to schedule the UL RMC according to Table 6.4.2.4.4.1-1. Since the UE has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC
3. Send continuously uplink power control "up" commands in the uplink scheduling information to the UE until the UE transmits at P_{UMAX} level. Allow at least [TBD ms] for the UE to reach P_{UMAX} level.
4. Ensure the UE beam towards the SS is locked using ACTIVATE BEAMLOCK for TxRx according to TS 38.508-1 [10] clause 4.5.
5. Measure spectrum flatness using Global In-Channel Tx-Test (Annex E) for the θ- and φ-polarizations, respectively. For TDD slots with transient periods are not under test.
6. Ensure the UE beam towards the SS is unlocked using DEACTIVATE BEAMLOCK according to TS 38.508-1 [10] clause 4.5.

NOTE1: When switching to DFT-s-OFDM waveform, as specified in the test configuration table 6.4.2.1.4.1-1, send an NR RRCReconfiguration message according to TS 38.508-1 [10] clause 4.6.3 Table 4.6.3-89 PUSCH-Config without CP-OFDM condition. When switching to CP-OFDM waveform, send an NR RRCReconfiguration message with CP-OFDM condition.

6.4.2.4.4.3 Message contents

Message contents are according to TS 38.508-1 [10] subclause 4.6.

6.4.2.4.5 Test requirement

Each of the *n* spectrum flatness functions, shall derive four ripple results in Annex E.4.4. The derived results shall not exceed the values in Figure 6.4.2.4.5-1: 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 6.4.2.4.5-1 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..5-1) must not be larger than 7 dB + TT, 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 + TT (see Figure 6.4.2.4.5-1).

The UE passes the test when the derived results for at least one polarization fulfil the test requirements.

Table 6.4.2.4.5-1: Test 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 +TT (p-p)
$F_{UL\_Meas} - F_{UL\_Low} <$ X MHz or $F_{UL\_High} - F_{UL\_Meas} <$ X MHz (Range 2)	9 + TT (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	

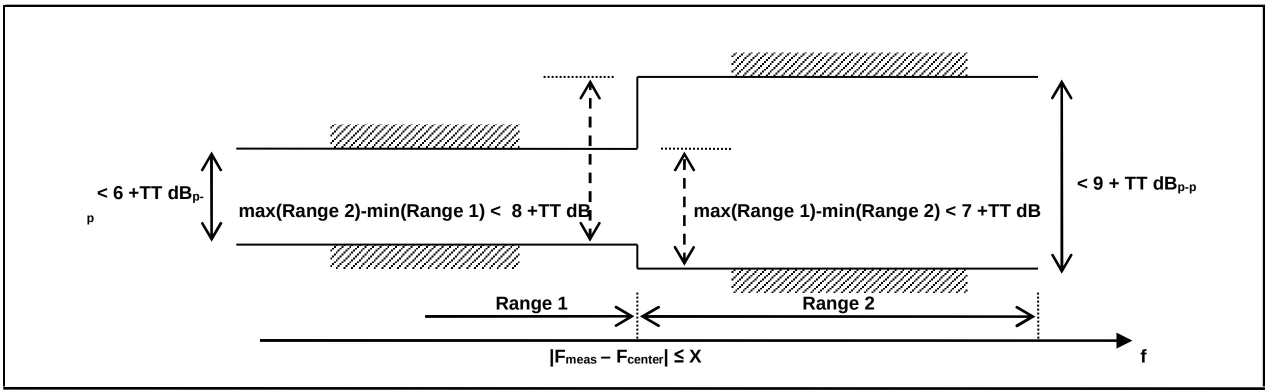

Figure 6.4.2.4.5-1: The limits for EVM equalizer spectral flatness with the maximum allowed variation of the coefficients indicated under normal conditions

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

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

- SA message contents in TS 38.508-1 subclause 4.6 is FFS.
- SA generic procedures with condition NR in TS 38.508-1 is FFS.
- Measurement Uncertainty and Test Tolerance are FFS.
- 38.101-2 Clause 6.3.4.3: Relative power tolerances are in square brackets..
- Whether and, if yes, how to test the requirement on shaping filter is FFS.

6.4.2.5.1 Test purpose

Same test purpose as in clause 6.4.2.4.1.

6.4.2.5.2 Test applicability

This test case applies to all types of NR UE release 15 and forward.

6.4.2.5.3 Minimum conformance requirements

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 6.4.2.5.3-1 for normal conditions, prior to the calculation of EVM. The limiting mask shall be placed to minimize the change in equalizer coefficients in a sum of squares sense.

Table 6.4.2.5.3-1: 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 centre 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.		

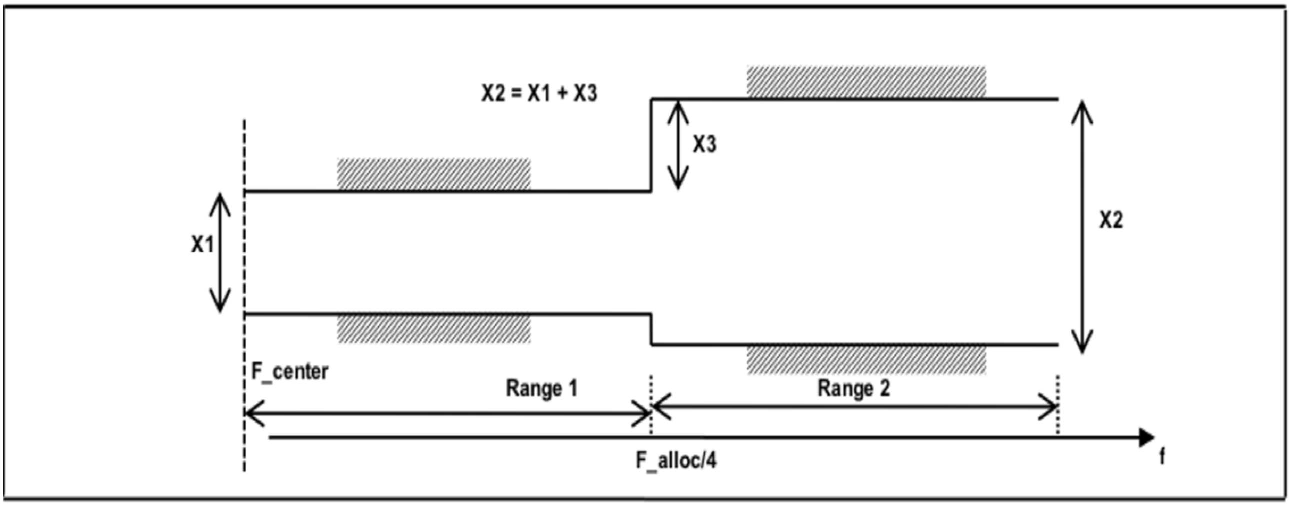

Figure 6.4.2.5.3-1: The limits for EVM equalizer spectral flatness with the maximum allowed variation. F_center denotes the centre frequency of the allocated block of PRBs. F_alloc denotes the bandwidth of the PRB allocation.

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

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

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

Where:

$|\tilde{a}_t(t,\tau)| = \text{IDFT}\{ |\tilde{a}_t(t,f)| e^{j\varphi(t,f)} \}$,

f is the frequency of the M allocated subcarriers,

$\tilde{a}(t,f)$ and $\varphi(t,f)$ are the amplitude and phase response, respectively of the transmit chain

0dB reference is defined as $20\log_{10}|\tilde{a}_t(t,0)|$

The normative reference for this requirement is TS 38.101-2 [3] clause 6.4.2.5.

6.4.2.5.4 Test description

6.4.2.5.4.1 Initial condition

Same initial conditions as in clause 6.4.2.4.4.1 with following exceptions:

- Instead of Table 6.4.2.4.4.1-1 → use Table 6.4.2.5.4.1-1

Table 6.4.2.5.4.1-1: Test Configuration

Initial Conditions			
Test Environment as specified in TS 38.508-1 [10] subclause 4.1		Normal	
Test Frequencies as specified in TS 38.508-1 [10] subclause 4.3.1		Low range, Mid range, High range	
Test Channel Bandwidths as specified in TS 38.508-1 [10] subclause 4.3.1		Lowest, Mid, Highest	
Test SCS as specified in TS 38.508-1 [10] subclause [TBD]		Lowest SCS per Channel Bandwidth	
Test Parameters			
Test ID	**Downlink Configuration**	**Uplink Configuration**	
	N/A	**Modulation**	**RB allocation (NOTE 1)**
1		DFT-s-OFDM pi/2-BPSK	Outer_Full
NOTE 1: The specific configuration of each RB allocation is defined in Table 6.1-1. NOTE 2: Test Channel Bandwidths are checked separately for each NR band, which applicable channel bandwidths are specified in Table 5.3.5-1.			

6.4.2.5.4.2 Test procedure

1 Set the UE in the Tx beam peak direction found with a 3D EIRP scan as performed in clause [TBD].

2. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format [0_1] for C_RNTI to schedule the UL RMC according to Table 6.4.2.5.4.1-1. Since the UE has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC

3. Send continuously uplink power control "up" commands in the uplink scheduling information to the UE until the UE transmits at P_{UMAX} level. Allow at least [TBD ms] for the UE to reach P_{UMAX} level.

4. Ensure the UE beam towards the SS is locked using ACTIVATE BEAMLOCK for TxRx according to TS 38.508-1 [10] clause 4.5.

5. Measure spectrum flatness using Global In-Channel Tx-Test (Annex E) for the θ- and φ-polarizations, respectively. For TDD slots with transient periods are not under test.

6. Ensure the UE beam towards the SS is unlocked using DEACTIVATE BEAMLOCK according to TS 38.508-1 [10] clause 4.5.

6.4.2.5.4.3 Message contents

Message contents are according to TS 38.508-1 [10] subclause 4.6.

6.4.2.5.5 Test requirement

Each of the *n* spectrum flatness functions, shall derive four ripple results in Annex E.4.4. The derived results shall not exceed the values in Table 6.4.2.5.5-1 and Figure 6.4.2.5.5-1:

Table 6.4.2.5.5-1: Test requirement 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 + TT (p-p)
F_meas – F_center > X MHz or F_center – F_meas < X MHz (Range 2)	X2	14 + TT (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 centre 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.		

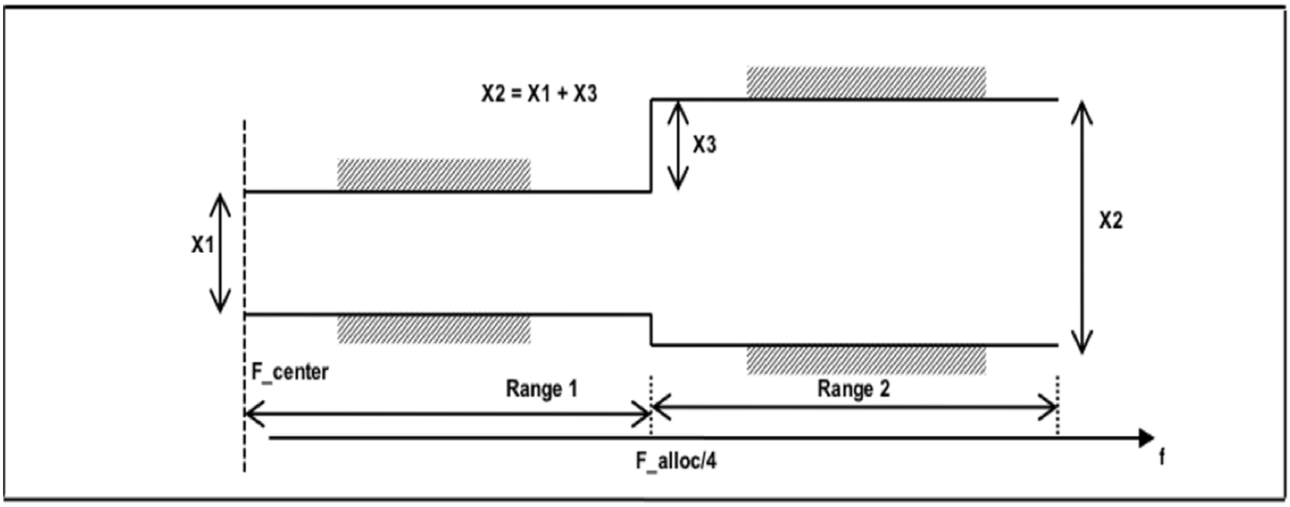

Figure 6.4.2.5.5-1: The limits for EVM equalizer spectral flatness with the maximum allowed variation. F_center denotes the centre frequency of the allocated block of PRBs. F_alloc denotes the bandwidth of the PRB allocation.

The UE passes the test when the derived results for at least one polarization fulfil the test requirements.

6.4A Transmit signal quality for CA

6.4A.1 Frequency error for CA

FFS.

6.4A.2 Transmit modulation quality for CA

FFS.

6.4A.2.1 Error vector magnitude for CA

FFS.

6.4A.2.2 Carrier leakage for CA

FFS.

6.4A.2.3 In-band emissions for CA

FFS.

6.4A.2.4 EVM equalizer spectrum flatness for CA

FFS.

6.4A.2.5 EVM spectral flatness for pi/2 BPSK modulation with spectrum shaping for CA

FFS.

6.4D Transmit signal quality for UL-MIMO

FFS.

6.5 Output RF spectrum emissions

Unwanted emissions are divided into "Out-of-band emission" and "Spurious emissions" in 3GPP RF specifications. This notation is in line with ITU-R recommendations such as SM.329 [7] and the Radio Regulations [TBD].

ITU defines:

Out-of-band emission = Emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious emissions.

Spurious emission = Emission on a frequency, or frequencies, which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products but exclude out-of-band emissions.

Unwanted emissions = Consist of spurious emissions and out-of-band emissions.

The UE transmitter spectrum emission consists of the three components; the occupied bandwidth (channel bandwidth), the Out Of Band (OOB) emissions and the far out spurious emission domain.

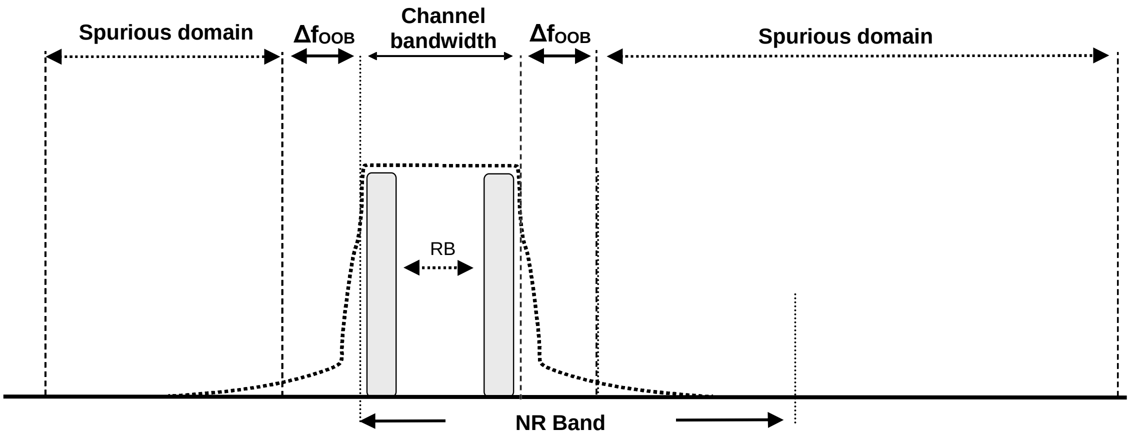

Figure 6.5-1: Transmitter RF spectrum

6.5.1 Occupied bandwidth

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

- Measurement Uncertainty FFS.
- Test Tolerances are FFS.
- Connection diagram for User Equipment part is FFS
- Default Downlink power levels for FR2 NR is TBD

6.5.1.1 Test purpose

To verify that the UE occupied bandwidth for all transmission bandwidth configurations supported by the UE are less than their specific limits

6.5.1.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

6.5.1.3 Minimum conformance requirements

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 6.5.1.2-1.

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

Table 6.5.1.2-1: Occupied channel bandwidth

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

The normative reference for this requirement is TS 38.101-2 [3] clause 6.5.1.

6.5.1.4 Test description

6.5.1.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, and channel bandwidths based on NR operating bands specified in table 5.3.5-1. All of these configurations shall be tested with applicable test parameters for each channel bandwidth and subcarrier spacing, are shown in table 6.5.1.4.1-1. The details of the uplink reference measurement channels (RMCs) are specified in Annexes A.2. Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2.

Table 6.5.1.4.1-1: Test Configuration Table

Initial Conditions			
Test Environment as specified in TS 38.508-1 [10] subclause 4.1		Normal	
Test Frequencies as specified in TS 38.508-1 [10] subclause 4.3.1		Low range, Mid range, High range	
Test Channel Bandwidths as specified in TS 38.508-1 [10] subclause 4.3.1		All	
Test SCS as specified in Table 5.3.5-1		Lowest SCS per Channel Bandwidth	
Test Parameters			
Test ID	**Downlink Configuration**	**Uplink Configuration**	
	N/A for occupied bandwidth test case	**Modulation**	**RB allocation (NOTE 1)**
1		CP-OFDM QPSK	Outer_full
NOTE 1: The specific configuration of each RB allocation is defined in Table 6.1-1.			

1. Connection between SS and UE is shown in TS 38.508-1 [10] Annex A, Figure A.3.1.2.1 for TE diagram and section [TBD] for UE diagram.

2. The parameter settings for the cell are set up according to TS 38.508-1 [10] subclause 4.4.3.

3. Downlink signals are initially set up according to Annex [TBD], and uplink signals according to Annex [TBD].

4. The UL Reference Measurement channels are set according to Table 6.5.1.4.1-1.
5. Propagation conditions are set according to Annex B.0
6. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity *NR*, Connected without release *On* according to TS 38.508-1 [10] clause 4.5. Message contents are defined in clause 6.5.1.4.3

6.5.1.4.2 Test procedure

1. Set the UE in the Tx beam peak direction found with a 3D EIRP scan as performed in clause [TBD].
2. SS sends uplink scheduling information for each UL HARQ process via PDSCH DCI format [0_1] for C_RNTI to schedule the UL RMC according to Table 6.5.1.4.1-1. Since the UL has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC.
3. Send continuously uplink power control "up" commands in every uplink scheduling information to the UE; allow at least [TBD msec] for the UE to reach [maximum output power].
4. Measure the EIRP spectrum distribution within two times or more frequency range over the requirement for Occupied Bandwidth specification centring on the current carrier frequency. The characteristics of the filter shall be approximately Gaussian (typical spectrum analyser filter). The measuring duration is one active uplink subframe. EIRP is captured from both polarizations, theta and phi.
5. Calculate the total EIRP from both polarizations, theta and phi, within the range of all frequencies measured in step 4 and save this value as “Total EIRP”. EIRP measurement procedure is defined in Annex K.
6. Sum up the power measured in theta and phi polarization upward from the lower boundary of the measured frequency range in step 4 and seek the limit frequency point by which this sum becomes 0.5% of “Total EIRP” and save this point as “Lower Frequency”.
7. Sum up the power measured in theta and phi polarization downward from the upper boundary of the measured frequency range in step 4 and seek the limit frequency point by which this sum becomes 0.5% of “Total EIRP” and save this point as “Upper Frequency”.
8. Calculate the difference “Upper Frequency” – “Lower Frequency” = “Occupied Bandwidth” between the two limit frequencies obtained in step 6 and step 7.

6.5.1.4.3 Message contents

Message contents are according to TS 38.508-1 [10] subclause 4.6.

6.5.1.5 Test requirement

The measured Occupied Bandwidth shall not exceed values in Table 6.5.1.5-1.

Table 6.5.1.5-1: Occupied channel bandwidth

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

6.5.2 Out of band emission

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 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}) the spurious requirements in subclause 6.5.3 are applicable.

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

- Measurement Uncertainties and Test Tolerances are FFS.
- The procedure to ensure UE is at maximum output power is TBD.
- Optimization in test frequencies is FFS.
- Connection diagram for User Equipment part is FFS
- Default Downlink power levels for FR2 NR is TBD

6.5.2.1.1 Test purpose

To verify that the power of any UE emission shall not exceed specified lever for the specified channel bandwidth.

6.5.2.1.2 Test applicability

This test case applies to all types of NR UE release 15 and forward.

6.5.2.1.3 Minimum conformance requirements

The power of any UE emission shall not exceed the levels specified in Table 6.5.2.1.3-1 for the specified channel bandwidth.

Table 6.5.2.1.3-1: General NR spectrum emission mask for 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

The normative reference for this requirement is TS 38.101-2 [3] clause 6.5.2.1.

6.5.2.1.4 Test description

6.5.2.1.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, and channel bandwidths based on NR operating bands specified in table 5.3.5-1. All of these configurations shall be tested with applicable test parameters for each channel bandwidth and subcarrier spacing, are shown in table 6.5.2.1.4.1-1. The details of the uplink reference measurement channels (RMCs) are specified in Annexes A.2. Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2.

Table 6.5.2.1.4.1-1: Test Configuration Table

Initial Conditions			
Test Environment as specified in TS 38.508-1 [10] subclause 4.1		Normal	
Test Frequencies as specified in TS 38.508-1 [10] subclause 4.3.1		Mid range	
Test Channel Bandwidths as specified in TS 38.508-1 [10] subclause 4.3.1		Lowest, Mid and Highest	
Test SCS as specified in Table 5.3.5-1		Lowest and Highest	
Test Parameters			
Test ID	**Downlink Configuration**	**Uplink Configuration**	
	N/A for Spectrum Emission Mask test case	**Modulation**	**RB allocation (NOTE 1)**
1		DFT-s-OFDM PI/2 BPSK	Outer_1RB_Left
2		DFT-s-OFDM PI/2 BPSK	Outer_1RB_Right
3		DFT-s-OFDM PI/2 BPSK	Outer_Full
4		DFT-s-OFDM QPSK	Outer_1RB_Left
5		DFT-s-OFDM QPSK	Outer_1RB_Right
6		DFT-s-OFDM QPSK	Outer_Full
7		DFT-s-OFDM 16 QAM	Outer_1RB_Left
8		DFT-s-OFDM 16 QAM	Outer_1RB_Right
9		DFT-s-OFDM 16 QAM	Outer_Full
10		DFT-s-OFDM 64 QAM	Outer_1RB_Left
11		DFT-s-OFDM 64 QAM	Outer_1RB_Right
12		DFT-s-OFDM 64 QAM	Outer_Full
13		CP-OFDM QPSK	Outer_1RB_Left
14		CP-OFDM QPSK	Outer_1RB_Right
15		CP-OFDM QPSK	Outer_Full
NOTE 1: The specific configuration of each RF allocation is defined in Table 6.1-1.			

1. Connection between SS and UE is shown in TS 38.508-1 [10] Annex A, Figure A.3.1.2.1 for TE diagram and section [TBD] for UE diagram.
2. The parameter settings for the cell are set up according to TS 38.508-1 [10] subclause 4.4.3.
3. Downlink signals are initially set up according to Annex [TBD], and uplink signals according to Annex [TBD].
4. The UL Reference Measurement channels are set according to Table 6.5.2.1.4.1-1.
5. Propagation conditions are set according to Annex B.0
6. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity *NR*, Connected without release *On* according to TS 38.508-1 [10] clause 4.5. Message contents are defined in clause 6.5.2.1.4.3

6.5.2.1.4.2 Test procedure

1. Set the UE in the Tx beam peak direction found with a 3D EIRP scan as performed in clause [TBD].
2. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format [0_1] for C_RNTI to schedule the UL RMC according to Table 6.5.2.1.4.2-1. Since the UL has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC.
3. Send continuously uplink power control "up" commands in every uplink scheduling information to the UE; allow at least [TBD msec] for the UE to reach [maximum output power].
4. Measure UE EIRP in the Tx beam peak direction in the channel bandwidth of the radio access mode according to the test configuration, which shall meet the requirements described in Table [TBD-Min peak EIRP requirement].

EIRP test procedure is defined in Annex K. The period of the measurement shall be at least one subframe (1 msec). EIRP is captured from both polarizations, theta and phi.

5. Measure the TRP of the transmitted signal with a measurement filter of bandwidths according to table 6.5.2.1.1.5-1. The centre frequency of the filter shall be stepped in continuous steps according to the same table. TRP shall be recorded for each step. The measurement period shall capture the active time slots. Total radiated power is measured according to TRP measurement procedure defined in Annex L. The measurement grid used for TRP measurement defined in Annex I. TRP is calculated considering both polarizations, theta and phi.

NOTE 1: When switching to DFT-s-OFDM waveform, as specified in the test configuration table 6.5.2.1.4.1-1, send an NR RRCReconfiguration message according to TS 38.508-1 [10] clause 4.6.3 Table 4.6.3-89 PUSCH-Config without CP-OFDM condition. When switching to CP-OFDM waveform, send an NR RRCReconfiguration message with CP-OFDM condition.

6.5.2.1.4.3 Message contents

Message contents are according to TS 38.508-1 [10] subclause 4.6.

6.5.2.1.5 Test requirement

The measured EIRP derived in step 4, shall fulfil requirements in Table [TBD-Min peak EIRP requirement] as appropriate, and the power (TRP) of any UE emission shall fulfil requirements in Table.6.5.2.1.5-1.

Table 6.5.2.1.5-1: General NR spectrum emission mask for Range 2

Spectrum emission limit (dBm)/ Channel bandwidth					
Δf_{OOB} (MHz)	50 MHz	100 MHz	200 MHz	400 MHz	Measurement bandwidth
± 0-5	-5 + TT	-5 + TT	-5 + TT	-5 + TT	1 MHz
± 5-10	-13 + TT	-5 + TT	-5 + TT	-5 + TT	1 MHz
± 10-20	-13 + TT	-13 + TT	-5 + TT	-5 + TT	1 MHz
± 20-40	-13 + TT	-13 + TT	-13 + TT	-5 + TT	1 MHz
± 40-100	-13 + TT	-13 + TT	-13 + TT	-13 + TT	1 MHz
± 100-200		-13 + TT	-13 + TT	-13 + TT	1 MHz
± 200-400			-13 + TT	-13 +TT	1 MHz
± 400-800				-13 + TT	1 MHz
NOTE 1: TT for each frequency and channel bandwidth is specified in Table 6.5.2.1.5-1a NOTE 2: At the boundary of spectrum emission limit, the first and last measurement position with a 1 MHz filter is the inside of +0.5MHz and -0.5MHz, respectively. NOTE 3: The measurements are to be performed above the upper edge of the channel and below the lower edge of the channel.					

Table 6.5.2.1.5-1a: Test Tolerance (Spectrum emission mask)

Test Metric	23.45GHz ≤ f ≤ 30.3GHz	30.3GHz < f ≤ 40.8GHz
IFF (DUT ≤ 15 cm)	TBD	TBD
IFF (DUT ≤ 30 cm)	[4.6] dB	[5.6] dB

NOTE: As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, 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.

6.5.2.2 Additional spectrum emissions mask

FFS.

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.

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

- Measurement Uncertainties and Test Tolerances are FFS.
- The procedure to ensure UE is at maximum output power is TBD.
- Connection diagram for User Equipment part is FFS
- Default Downlink power levels for FR2 NR is TBD

6.5.2.3.1 Test purpose

To verify that UE transmitter does not cause unacceptable interference to adjacent channels in terms of Adjacent Channel Leakage power Ratio (ACLR).

6.5.2.3.2 Test applicability

This test case applies to all types of NR UE release 15 and forward.

6.5.2.3.3 Minimum conformance requirements

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 6.5.2.3.3-1.

If the measured adjacent channel power is greater than –35 dBm then the NRACLR shall be higher than the value specified in Table 6.5.2.3.3-1.

Table 6.5.2.3.3-1: 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	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

The normative reference for this requirement is TS 38.101-2 [3] clause 6.5.2.3.1.

6.5.2.3.4 Test description

6.5.2.3.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, and channel bandwidths based on NR operating bands specified in table 5.3.5-1. All of these configurations shall be tested with applicable test parameters for each channel bandwidth and subcarrier spacing, are shown in table 6.5.2.3.4.1-1. The details of the uplink reference measurement channels (RMCs) are specified in Annexes A.2. Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2.

Table 6.5.2.3.4.1-1: Test Configuration Table

Default Conditions						
Test Environment as specified in TS 38.508-1 [10] subclause 4.1					Normal	
Test Frequencies as specified in TS 38.508-1 [10] subclause 4.3.1					Low range, High range	
Test Channel Bandwidths as specified in TS 38.508-1 [10] subclause 4.3.1					Lowest, Mid, and Highest	
Test SCS as specified in Table 5.3.5-1					Lowest and Highest	
Test Parameters						
Test ID	**Freq**	**ChBw**	**SCS**	**Downlink Configuration**	**Uplink Configuration**	
		Default	Default	N/A for Adjacent Channel Leakage Ratio test case	**Modulation**	**RB allocation (NOTE 1)**
1	Low				DFT-s-OFDM PI/2 BPSK	Outer_1RB_Left
2	High				DFT-s-OFDM PI/2 BPSK	Outer_1RB_Right
3	Default				DFT-s-OFDM PI/2 BPSK	Outer_Full
4	Low				DFT-s-OFDM QPSK	Outer_1RB_Left
5	High				DFT-s-OFDM QPSK	Outer_1RB_Right
6	Default				DFT-s-OFDM QPSK	Outer_Full
7	Low				DFT-s-OFDM 16 QAM	Outer_1RB_Left
8	High				DFT-s-OFDM 16 QAM	Outer_1RB_Right
9	Default				DFT-s-OFDM 16 QAM	Outer_Full
10	Default				DFT-s-OFDM 64 QAM	Outer_Full
11	Low				CP-OFDM QPSK	Outer_1RB_Left
12	High				CP-OFDM QPSK	Outer_1RB_Right
13	Default				CP-OFDM QPSK	Outer_Full
NOTE 1: The specific configuration of each RF allocation is defined in Table 6.1-1.						

1. Connection between SS and UE is shown in TS 38.508-1 [10] Annex A, Figure A.3.1.2.1 for TE diagram and section [TBD] for UE diagram.

2. The parameter settings for the cell are set up according to TS 38.508-1 [10] subclause 4.4.3.

3. Downlink signals are initially set up according to Annex [TBD], and uplink signals according to Annex [TBD].

4. The UL Reference Measurement channels are set according to Table 6.5.2.3.4.1-1.

5. Propagation conditions are set according to Annex B.0.

6. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity *NR*, Connected without release *On* according to TS 38.508-1 [10] clause 4.5. Message contents are defined in clause 6.5.2.3.4.3

6.5.2.3.4.2 Test procedure

1. Set the UE in the Tx beam peak direction found with a 3D EIRP scan as performed in clause [TBD].

2. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format [0_1] for C_RNTI to schedule the UL RMC according to Table 6.5.2.3.1.4.1-1. Since the UL has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC.

3. Send continuously uplink power control "up" commands in every uplink scheduling information to the UE; allow at least [TBD msec] for the UE to reach [maximum output power].

4. Measure TRP of the transmitted signal for the assigned NR channel with a rectangular measurement filter with bandwidths according to Table 6.5.2.3.5-1. Total radiated power is measured according to TRP measurement procedure defined in Annex L and measurement grid specified in [TBD]. TRP is calculated considering both polarizations, theta and phi.

5. Measure TRP of the first NR adjacent channel on both lower and upper side of the assigned NR channel, respectively using a rectangular measurement filter with bandwidths according to Table 6.5.2.3.5-1. Total

radiated power is measured according to TRP measurement procedure defined in Annex L. The measurement grid used for TRP measurement defined in Annex I. TRP is calculated considering both polarizations, theta and phi.

6. Calculate the ratios of the power between the values measured in step 4 over step 5 for lower and upper NR ACLR, respectively.

NOTE 1: When switching to DFT-s-OFDM waveform, as specified in the test configuration table 6.5.2.3.4.1-1, send an NR RRCReconfiguration message according to TS 38.508-1 [x] clause 4.6.3 Table 4.6.3-89 PUSCH-Config without CP-OFDM condition. When switching to CP-OFDM waveform, send an NR RRCReconfiguration message with CP-OFDM condition.

6.5.2.3.4.3 Message contents

Message contents are according to TS 38.508-1 [10] subclause 4.6.

6.5.2.3.5 Test requirement

If the measured adjacent channel power, derived in step 5, is greater than -35 dBm then the measured NR ACLR, derived in step 6, shall be higher than the limits in table 6.5.2.3.5-1.

Table 6.5.2.3.5-1: 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	17 + TT dB	17 + TT dB	17 + TT dB	17 + TT dB
NR_{ACLR} for band n260	16 + TT dB	16 + TT dB	16 + TT dB	16 + TT 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
NOTE 1: TT for each frequency and channel bandwidth is specified in Table 6.5.2.3.5-1a				

Table 6.5.2.3.5-1a: Test Tolerance (Adjacent channel leakage ratio)

Test Metric	23.45GHz ≤ f ≤ 30.3GHz	30.3GHz < f ≤ 40.8GHz
IFF (DUT ≤ 15 cm)	TBD	TBD
IFF (DUT ≤ 30 cm)	[4.6] dB	[5.0] dB

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. The spurious emission limits are specified in terms of general requirements inline with SM.329 [7] and *NR* operating band requirement to address UE co-existence.

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.

6.5.3.1 Transmitter Spurious emissions

Editor’s Note: Following aspects are missing or under discussion:

- Testability issue for 6GHz ~ [12.75GHz] is identified. How to treat this frequency range is TBD.
- TRP Measurement uncertainty is TBD
- UE max power settling time is TBD
- RAN 4 to fix the in 38.101-2: Requirements test freq range sign to change from < to ≤ to include 2nd harmonic
- TP analysis in 38.905 has RB # [TBD] and it needs to be updated with justification and align with RB # 0
- 3D EIRP scan procedure and Annex is [TBD]
- Message contents are not complete

6.5.3.1.1 Test purpose

To verify that UE transmitter does not cause unacceptable interference to other channels or other systems in terms of transmitter spurious emissions.

6.5.3.1.2 Test applicability

This test case applies to all types of *NR* UE release 15 and forward.

6.5.3.1.3 Minimum conformance requirements

Unless otherwise stated, the spurious emission limits apply for the frequency ranges that are more than F_{OOB} (MHz) in Table 6.5.3.1.3-1 starting from the edge of the assigned *NR* channel bandwidth. The spurious emission limits in Table 6.5.3.1.3-2 apply for all transmitter band configurations (NRB) and channel bandwidths.

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

Table 6.5.3.1.3-1: 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

The spurious emission limits in table 6.5.3.1.3-2 apply for all transmitter band configurations (RB) and channel bandwidths.

Table 6.5.3.1.3-2: 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	

The normative reference for this requirement is TS 38.101-2 subclause 6.5.3.

6.5.3.1.4 Test description

6.5.3.1.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the Subscriber Station (SS) to take with the UE to reach the correct measurement state.

Table 6.5.3.1.4.1-1: Test Configuration Table

Initial Conditions			
Test Environment as specified in TS 38.508-1 [10] subclause 4.1		Normal	
Test Frequencies as specified in TS 38.508-1 [10] subclause 4.3.1		Mid range	
Test Channel Bandwidths as specified in TS 38.508-1 [10] subclause 4.3.1		Highest	
Test SCS as specified in Table 5.3.5-1		Highest and Lowest	
Test Parameters			
Test ID	**Downlink Configuration**	**Uplink Configuration**	
	N/A for Spurious Emissions testing	**Modulation**	**RB allocation (NOTE 1, NOTE 2)**
1		CP-OFDM QPSK	Outer_Full
2		CP-OFDM QPSK	1RB
NOTE 1: The specific configuration of each RB allocation is defined in Table 6.1-1 Common UL configuration NOTE 2: The 1 RB allocation shall be tested at RB # 0.			

1. Connection between SS and UE is shown in TS 38.508-1 [10] Annex A, Figure A.3.3.1.1 for TE diagram and Figure A.3.4.1.1 for UE diagram.

2. The parameter settings for the cell are set up according to TS 38.508-1 [10] subclause 4.4.3 .

3. Downlink signals are initially set up according to Annex C.0, C.1 and C.3.0 , and uplink signals according to Annex G.0, G.1 and G.3.0 .

4. The UL Reference Measurement channels are set according to Table 6.5.3.1.4.1-1

5. Propagation conditions are set according to Annex B.0.

6. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity *NR* according to TS 38.508-1 [10] clause 4.5. Message contents are defined in clause 6.5.3.1.4.3.

6.5.3.1.4.2 Test procedure

1. Set the UE in the Tx beam peak direction found with a 3D EIRP scan as performed in Annex [TBD].

2. SS sends uplink scheduling information for each UL HARQ process via PDSCH DCI format [0_1] for C_RNTI to schedule the UL RMC according to Table 6.5.1.4.1-1. Since the UL has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC.

3. Send continuously uplink power control "up" commands in every uplink scheduling information to the UE; allow at least [TBD msec] for the UE to reach P_{UMAX} .

4. SS activates the UE Beamlock Function (UBF) by performing the procedure as specified in TS 38.508-1 [10] clause 4.9.2 using condition Tx only.

5. Measure the spurious emissions as per steps outlined below:

   (a) Perform coarse TRP measurements to identify spurious emission frequencies and corresponding power level according to the procedures in Annex L, using coarse TRP measurement grid selection criteria as per Table I-3 in Annex I. The measurement is completed in both polarizations θ and ϕ over frequency range and measurement bandwidth according to Table 6.5.3.1.3-2. Optionally, a larger and non-constant measurement bandwidth than that of Table 6.5.3.1.3-2 may be applied as long as the SNR (ratio of test limit to floor noise of test equipment) ≥ 10dB is guaranteed. The measurement period shall capture the [active time slots]. For each spurious emission frequency with coarse TRP identified to be less than an offset dB from the TRP limit according to Table 6.5.3.1.3-2, continue with fine TRP procedures according to step (b).

The offset value shall be the TRP measurement uncertainty at 95% confidence level including the effect of coarse grid measurement uncertainty element. Different coarse TRP grids and corresponding offset values may be used for different frequencies. The coarse TRP grid and offset values used shall be recorded in the test report.

(b) Measure fine TRP measurements according to procedures in Annex L, using fine TRP measurement grid selection criteria as per Table I-3 in Annex I, for each of the spurious emission frequency identified in step (a). Apply a measurement bandwidth according to Table 6.5.3.1.3-2.

6. SS deactivates the UE Beamlock Function (UBF) by performing the procedure as specified in TS 38.508-1 [10] clause 4.9.3.

NOTE 1: The frequency range defined in Table 6.5.3.1.3-2 may be split into ranges. For each range a different test system, e.g. antenna and/or chamber, may be used. To pass the test case all verdicts of the frequency ranges must pass.

NOTE 2: When switching to CP-OFDM waveform, as specified in the test configuration Table 6.5.3.1.4.1-1, send an RRCReconfiguration message according to TS 38.508-1 [10] clause 4.6.3 Table 4.6.3-89 with CP-OFDM condition.

NOTE 3:

The coarse TRP measurement grid and corresponding offset dB value referred in step 5(a) above, for some valid grids can be found in TR 38.903 section B.18.

6.5.3.1.4.3 Message contents

Message contents are according to TS 38.508-1 [10] subclause 4.6.

6.5.3.1.5 Test requirement

This clause specifies the requirements for the specified *NR* band for Transmitter Spurious emissions requirement with frequency range as indicated in Table 6.5.3.1.5-1.

The measured maximum EIRP or TRP power of spurious emission, derived in step 3, shall not exceed the described value in Table 6.5.3.1.5-1.

Unless otherwise stated, the spurious emission limits apply for the frequency ranges that are more than F_{OOB} (MHz) in Table 6.5.3.1.3-1 starting from the edge of the assigned *NR* channel bandwidth. The spurious emission limits in Table 6.5.3.1.5-1 apply for all transmitter band configurations (NRB) and channel bandwidths.

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

Table 6.5.3.1.5-1: Spurious emissions test requirements

Frequency Range	Maximum Level	Measurement bandwidth	NOTE
6 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	
NOTE 1: Applies for Band n257, n258, n260			

6.5.3.2 Spurious emission band UE co-existence

FFS.

6.5A Output RF spectrum emissions for CA

6.5A.1 Occupied bandwidth for CA

FFS.

6.5A.2 Out of band emission for CA

6.5A.2.1 Spectrum Emission Mask for CA

FFS.

6.5A.2.2 Adjacent channel leakage ratio for CA

FFS.

6.5D Output RF spectrum emissions for UL-MIMO

6.5D.1 Occupied bandwidth for UL-MIMO

FFS.

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

FFS.

6.5D.3 Spurious emissions for UL-MIMO

FFS.

7 Receiver characteristics

TBD.

7.1 General

Editor's Note:

- Test configurations/environments that require new spherical scan shall be included in test procedure section and identifying such scenarios is currently FFS and owned by RAN5.

Unless otherwise stated, the receiver characteristics are specified over the air (OTA). The reference receive sensitivity (REFSENS) is defined assuming a 0 dBi reference antenna located at the centre of the quiet zone.

For Rx test cases the identified beam peak direction can be stored and reused for a device under test in various configurations/environments for the full duration of device testing as long as beam peak direction is the same.

Unless otherwise stated, Channel Bandwidth shall be prioritized in the selecting of test points. Subcarrier spacing shall be selected after Test Channel Bandwidth is selected.

7.2 Diversity characteristics

FFS.

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

Editor's Note:

- Message contents is not complete.

- Measurement uncertainty and Test tolerance is not complete.

- Testability items pending:

  - Details on 3D EIS scan to find Rx beam peak direction is not complete in 38.810 (grid type, no of points)

  - The 3D EIS scan test time optimization in RAN 4/ RAN 5 is FFS (existing EIS based test time is impracticable and few 100s of hours)

  - Test procedure step 7 EIS equation pending RAN 4 agreement.

- Testing extreme conditions is FFS- Statistical model in Annex H.2 (currently based on LTE model) needs to be validated to confirm that it is also applicable for FR2

7.3.2.1 Test purpose

To verify the UE's ability to receive data with a given average throughput for a specified reference measurement channel, under conditions of low signal level, ideal propagation and no added noise.

A UE unable to meet the throughput requirement under these conditions will decrease the effective coverage area of an g-NodeB.

7.3.2.2 Test applicability

This test case applies to all types of *NR* UE release 15 and forward.

7.3.2.3 Minimum conformance requirements

The reference sensitivity power level REFSENS is the minimum mean power applied to each one of the UE antenna ports for all UE categories, at which the throughput shall meet or exceed the requirements for the specified reference measurement channel.

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2 and A.3 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5) with peak reference sensitivity specified in Table 7.3.2.3-1 and Table 7.3.2.3-4. 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 for power class 1

Operating band	REFSENS (dBm) / Channel bandwidth			
	50 MHz	**100 MHz**	**200 MHz**	**400 MHz**
n257	-97.5	-94.5	-91.5	-88.5
n258	-97.5	-94.5	-91.5	-88.5
n260	-94.5	-91.5	-88.5	-85.5
n261	-97.5	-94.5	-91.5	-88.5
NOTE 1: The transmitter shall be set to P_{UMAX} as defined in subclause 6.2.4				

Table 7.3.2.3-2: 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
NOTE 1: The transmitter shall be set to P_{UMAX} as defined in subclause 6.2.4				

Table 7.3.2.3-3: Reference sensitivity for power class 3

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
NOTE 1: The transmitter shall be set to P_{UMAX} as defined in subclause 6.2.4				

Table 7.3.2.3-4: Reference sensitivity for power class 4

Operating band	REFSENS (dBm) / Channel bandwidth			
	50 MHz	**100 MHz**	**200 MHz**	**400 MHz**
n257	-97.0	-94.0	-91.0	-88.0
n258	-97.0	-94.0	-91.0	-88.0
n260	-95.0	-92.0	-89.0	-86.0
n261	-97.0	-94.0	-91.0	-88.0
NOTE 1: The transmitter shall be set to P_{UMAX} as defined in subclause 6.2.4				

Table 7.3.2.3-5: Uplink configuration for reference sensitivity

NR Band / Channel bandwidth / N_{RB} / SCS / Duplex mode						
NR Band	50 MHz	100 MHz	200 MHz	400 MHz	SCS	Duplex Mode
n257	32	64	128	256	120 kHz	TDD
n258	32	64	128	256	120 kHz	TDD
n260	32	64	128	256	120 kHz	TDD
n261	32	64	128	256	120 kHz	TDD

Unless given by Table 7.3.2.3-6, the minimum requirements specified in Tables 7.3.2.3-1 to 7.3.2.3-4 shall be verified with the network signalling value NS_200 configured.

Table 7.3.2.3-6: Network Signalling value for reference sensitivity

NR Band	Network Signalling value

For the UE which supports inter-band carrier aggregation, the minimum requirement for reference sensitivity in Tables 7.3.2.3-1 to 7.3.2.3-4 shall be increased by the amount given in $\Delta R_{IB,c}$ defined in subclause [TBD] for the applicable operating bands.

The normative reference for this requirement is TS 38.101-2 [3] clause 7.3.2.

7.3.2.4 Test description

7.3.2.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, and channel bandwidths based on NR operating bands specified in Table 5.3.5-1. All of these configurations shall be tested with applicable test parameters for each channel bandwidth, and are shown in Table 7.3.2.4.1-1, Table 7.3.2.4.1-2, and Table 7.3.2.4.1-3 The details of the uplink reference measurement channels (RMCs) are specified in Annex A.2. Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2.

Table 7.3.2.4.1-1: Test Configuration Table

Initial Conditions				
Test Environment as specified in TS 38.508-1 [5] subclause 4.1			Normal	
Test Frequencies as specified in TS 38.508-1 [5] subclause 4.3.1			Low range, Mid range, High range	
Test Channel Bandwidths as specified in TS 38.508-1 [5] subclause 4.3.1			Highest supported BW, in addition to 100MHz and 200MHz	
Test SCS as specified in Table 5.3.5-1			120kHz	
Test Parameters				
Test ID	**Downlink Configuration**		**Uplink Configuration**	
	Modulation	**RB allocation**	**Modulation**	**RB allocation**
1	CP-OFDM QPSK	Full RB (NOTE 1)	DFT-s-OFDM QPSK	REFSENS (NOTE 2)
NOTE 1: Full RB allocation shall be used per each SCS and channel BW as specified in Table 7.3.2.4.1-2. NOTE 2: REFSENS refers to Table 7.3.2.4.1-3 which defines uplink RB configuration and start RB location for each SCS, channel BW and NR band.				

Table 7.3.2.4.1-2: Downlink Configuration of each RB allocation

Channel Bandwidth	SCS kHz	LCRBmax	RB allocation (LCRB@RBstart)
50MHz	120	32	32@0
100MHz	120	64	64@0
200MHz	120	128	128@0
400MHz	120	256	256@0
NOTE 1: Test Channel Bandwidths are checked separately for each NR band, the applicable channel bandwidths are specified in Table 5.3.5-1.			

Table 7.3.2.4.1-3: Uplink configuration for reference sensitivity, LCRB@RBstart format

Operating Band	SCS kHz	50 MHz	100 MHz	200 MHz	400 MHz	Duplex Mode
n257	120	32@0	64@0	128@0	256@0	TDD
n258	120	32@0	64@0	128@0	256@0	TDD
n260	120	32@0	64@0	128@0	256@0	TDD
n261	120	32@0	64@0	128@0	256@0	TDD

1. Connection between SS and UE is shown in TS 38.508-1 [10] Annex A , Figure A.3.3.1.1 for TE diagram and Figure A.3.4.1.1 for UE diagram.
2. The parameter settings for the cell are set up according to TS 38.508-1 [10] subclause 4.4.3.
3. Downlink signals are initially set up according to Annex C.0, C.1 and C.3.1 , and uplink signals according to Annex G.0, G.1 and G.3.1.
4. The UL Reference Measurement channels are set according to Table 7.3.2.4.1-1, Table 7.3.2.4.1-2, and Table 7.3.2.4.1-3.
5. Propagation conditions are set according to Annex B.0.
6. Ensure the UE is in State RRC_CONNECTED with generic procedure parameters Connectivity *NR*, Connected without release *On* according to TS 38.508-1 [10] clause 4.5. Message contents are defined in clause 7.3.2.4.3.

7.3.2.4.2 Test procedure

1. Set the UE in the Rx beam peak direction found with a 3D EIS scan as performed in clause [TBD].
2. SS transmits PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to Table 7.3.2.4.1-1. The SS sends downlink MAC padding bits on the DL RMC.
3. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format [0_1] for C_RNTI to schedule the UL RMC according to Tables 7.3.2.4.1-1. Since the UE has no payload data to send, the UE transmits uplink MAC padding bits on the UL RMC.
4. Send continuously uplink power control "up" commands in the uplink scheduling information to the UE to ensure the UE transmits P_{UMAX} for at least the duration of the Throughput measurement. Allow at least [TBD msec] for the UE to reach P_{UMAX} level.
5. Determine EIS_{θ} for the θ-polarization, i.e., the lowest power level for the θ-polarization at which the throughput exceeds the test requirement of 95%, by changing the power level of the wanted signal with a step size of[0.5] dB for the final step. For each power step measure the average throughput for a duration sufficient to achieve statistical significance according to Annex H.2.
6. Repeat step 5 to determine EIS_{φ} for the φ-polarization.
7. From the values for EIS_{θ} and EIS_{φ} determined in step 5 and 6 calculate the resulting EIS for the total component according to [$EIS = [1/EIS_{\theta} + 1/EIS_{\varphi}]^{-1}$] (formula applies for linear units).

8. Compare the dB value of the total component EIS value calculated in step 7 to the test requirement in table 7.3.2.5-1. If the EIS value is lower or equal to the value in table 7.3.2.5-1, pass the UE. Otherwise fail the UE.

7.3.2.4.3 Message contents

Message contents are according to TS 38.508-1 [10] subclause 4.6.

7.3.2.5 Test requirement

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annex A.2 and A.3 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5) with peak reference sensitivity specified in Tables 7.3.2.5-1 to 7.3.2.5-4. The requirement is verified with the test metric of EIS (Link=Beam peak search grids, Meas=Link Angle).Table 7.3.2.5-1: Reference sensitivity for power class 1

Operating band	REFSENS (dBm) / Channel bandwidth			
	50 MHz	100 MHz	200 MHz	400 MHz
n257	-97.5+TT	-94.5+TT	-91.5+TT	-88.5+TT
n258	-97.5+TT	-94.5+TT	-91.5+TT	-88.5+TT
n260	-94.5+TT	-91.5+TT	-88.5+TT	-85.5+TT
n261	-97.5+TT	-94.5+TT	-91.5+TT	-88.5+TT

Table 7.3.2.5-2: Reference sensitivity for power class 2

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

Table 7.3.2.5-3: Reference sensitivity for power class 3

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

Table 7.3.2.5-3a: Test Tolerance (Reference sensitivity for power class 3)

Test Metric	f ≤ 40.8 GHz
IFF (DUT ≤ 15 cm)	[3.3] dB
IFF (DUT ≤ 30 cm)	[3.2] dB

Table 7.3.2.5-4: Reference sensitivity for power class 4

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

7.3A Reference sensitivity for CA

7.3A.1 General

FFS.

7.3A.2 Reference sensitivity power level for CA

7.3A.2.1 Intra-band contiguous CA

FFS.

7.3D Reference sensitivity for UL-MIMO

FFS.

7.4 Maximum input level

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

- UL power level configuration is missing in TS 38.101-2.
- Maximum input level requirement of DL 64QAM is TBD in TS 38.101-2.
- DL RMC of 64QAM is FFS in TS 38.101-2.
-
- Uplink signals (Annex G) is not complete.
- The UE Rx beam peak direction found procedure with a 3D EIS scan is not complete in TR 38.810.
- Measurement uncertainty and test tolerances are FFS.

Editor's note: The requirement in this test case is not testable due to maximum input level achievable in OTA test setup. Thus the test case will not be tested.

7.4.1 Test purpose

Maximum input level tests the UE's ability to receive data with a given average throughput for a specified reference measurement channel, under conditions of high signal level, ideal propagation and no added noise.

A UE unable to meet the throughput requirement under these conditions will decrease the coverage area near to a g-NodeB.

7.4.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

7.4.3 Minimum conformance requirements

The maximum input level is defined as the maximum mean power, for which the 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 Annex A (with one sided dynamic OCNG Pattern OP.1 TDD for the DL-signal) with parameters specified in Table 7.4.3-1. The requirement is verified with the test metric of EIS (Link=RX beam peak direction, Meas=Link angle).

Table 7.4.3-1: Maximum input level

Rx Parameter	Units	Channel bandwidth			
		50 MHz	100 MHz	200 MHz	400 MHz
Power in transmission bandwidth configuration	dBm	TBD (NOTE 2)			
NOTE 1: VOID NOTE 2: Reference measurement channel is specified in Annex A.3.3: [64QAM MCS details] variant with one sided dynamic OCNG Pattern as described in Annex A.					

This requirement may be fulfilled by a test using an alternative reference measurement channel with parameters specified in Table 7.4.3-2.

Table 7.4.3-2: 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: VOID. NOTE 2: Reference measurement channel is specified in Annex A.3.3: QPSK, R=1/3 variant with one sided dynamic OCNG Pattern as described in Annex A.					

The normative reference for this requirement is TS 38.101-2 [3] clause 7.4.

7.4.4 Test description

7.4.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in table 5.3.5-1. All of these configurations shall be tested with applicable test parameters for each combination of channel bandwidth and sub-carrier spacing, are shown in table 7.4.4.1-1. The details of the uplink and downlink reference measurement channels (RMC) are specified in Annexes A.2 and A.3. The details of the OCNG patterns used are specified in Annex A.5. Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2.

Table 7.4.4.1-1: Test Configuration Table

Initial Conditions			
Test Environment as specified in TS 38.508-1 [5] subclause 4.1		Normal	
Test Frequencies as specified in TS 38.508-1 [5] subclause 4.3.1		Mid range	
Test Channel Bandwidths as specified in TS 38.508-1 [5] subclause 4.3.1		Lowest, Mid, Highest	
Test SCS as specified in Table 5.3.5-1		120kHz	
Test Parameters for Channel Bandwidths			
Downlink Configuration		**Uplink Configuration**	
Modulation	**RB allocation**	**Modulation**	**RB allocation**
CP-OFDM QPSK	NOTE1	DFT-s-OFDM QPSK	NOTE2
NOTE 1: The specific configuration of downlink RB allocation is defined in Table 7.3.2.4.1-2. NOTE 2: The specific configuration of uplink RB allocation is defined in Table 7.3.2.4.1-3.			

1. Connection between SS and UE is shown in TS 38.508-1 [10] Annex A, Figure A.3.3.1.1 for TE diagram and Figure A.3.4.1.1 for UE diagram.
2. The parameter settings for the cell are set up according to TS 38.508-1 [10] subclause 4.4.3.
3. Downlink signals are initially set up according to Annex C, and uplink signals according to Annex [TBD].
4. The DL and UL Reference Measurement channels are set according to Table 7.4.4.1-1.
5. Propagation conditions are set according to Annex B.0.
6. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity *NR* according to TS 38.508-1 [10] clause 4.5. Message content are defined in clause 7.4.4.3.

7.4.4.2 Test procedure

1. Set the UE in the Rx beam peak direction found with a 3D EIS scan as performed in clause [TBD].

2. SS transmits PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to Table 7.4.4.1-1. The SS sends downlink MAC padding bits on the DL RMC.

3. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format [0_1] for C_RNTI to schedule the UL RMC according to Table 7.4.4.1-1. Since the UL has no payload data to send, the UE transmits uplink MAC padding bits on the UL RMC.

4. Set the Downlink signal level for θ-polarization to the value as defined in Table 7.4.5-1. Send Uplink power control commands to the UE (less or equal to [TBD] dB step size should be used), to ensure that the UE output power is within [TBD] dB of the target power level in Table 7.4.5-1, for at least the duration of the Throughput measurement.

5. Measure the average throughput for a duration sufficient to achieve statistical significance according to Annex H.2.

6. Repeat steps from 4 to 5, for the downlink signal from φ-polarization.

7. Compare the results for both the θ-polarization and φ-polarization against the requirement. If both results meet the requirements, pass the UE.

7.4.4.3 Message contents

Message contents are according to TS 38.508-1 [10] subclause 4.6.

7.4.5 Test requirement

The throughput measurement derived in test procedure shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annex A with parameters specified in Tables 7.4.5-1.

Table 7.4.5-1: Maximum input level

Rx Parameter	Units	Channel bandwidth			
		50 MHz	100 MHz	200 MHz	400 MHz
Power in Transmission Bandwidth Configuration	dBm	-51 (NOTE 2,3) for band n257, n258 and n261 -59 (NOTE 2,3) for band n260			
NOTE 1: Void. NOTE 2: Reference measurement channel is specified in Annex A.3.3: QPSK, R=1/3 variant with one sided dynamic OCNG Pattern as described in Annex A. NOTE 3: The test requirements deviate from minimum requirements by 26dB relaxation for 24.25 ~ 29.5 GHz and 34 dB relaxation for 37 ~ 40 GHz.					

7.4A Maximum input level for CA

FFS

7.4D Maximum input level for UL-MIMO

FFS

7.5 Adjacent channel selectivity

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

- Measurement Uncertainty and Test Tolerances are FFS.
- UL power level configuration is TBD.
- Throughput calculation procedure is TBD (measurement period as well as dependencies with polarizations).
- Connection diagram for User Equipment part is FFS.

7.5.1 Test purpose

Adjacent channel selectivity tests the UE's ability to receive data with a given average throughput for a specified reference measurement channel, in the presence of an adjacent channel signal at a given frequency offset from the centre frequency of the assigned channel, under conditions of ideal propagation and no added noise.

7.5.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

7.5.3 Minimum conformance requirements

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 Radiated Interface Boundary (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 7.5.3-1 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 7.5.3-2 and Table 7.5.3-3 where the throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A(with QPSK, R=1/3 and one sided dynamic OCNG Pattern OP.1 TDD 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 7.5.3-1: Adjacent channel selectivity

		Channel bandwidth			
Rx Parameter	**Units**	**50 MHz**	**100 MHz**	**200 MHz**	**400 MHz**
ACS for band n257, n258, n261	dB	23	23	23	23
ACS for band n260	dB	22	22	22	22

Table 7.5.3-2: 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 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 7.3.2.3-1., 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 $(\lceil \lvert F_{Interferer} \rvert / SCS \rceil + 0.5) SCS$ MHz with SCS the sub-carrier spacing of the wanted signal in MHz. Wanted and interferer signal have same SCS.					

Table 7.5.3-3: 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 A with one sided dynamic OCNG Pattern TDD as described in Annex A.5.2.1 and set-up according to Annex C. NOTE 2: The absolute value of the interferer offset FInterferer (offset) shall be further adjusted to $(\lceil \lvert F_{Interferer} \rvert / SCS \rceil + 0.5) SCS$ MHz with SCS the sub-carrier spacing of the wanted signal in MHz. Wanted and interferer signal have same SCS.					

The normative reference for this requirement is TS 38.101-2 [3] clause 7.5.

7.5.4 Test description

7.5.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, and channel bandwidths based on NR operating bands specified in table 5.3.5-1. All of these configurations shall be tested with applicable test parameters for each channel bandwidth and subcarrier spacing, are shown in table 7.5.4.1-1. The details of the uplink and downlink reference measurement channels (RMCs) are specified in Annexes A. The details of the OCNG patterns used are specified in Annex A. Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2.

Table 7.5.4.1-1: Test Configuration

Initial Conditions				
Test Environment as specified in TS 38.508-1 [10] subclause 4.1		Normal		
Test Frequencies as specified in TS 38.508-1 [10] subclause 4.3.1		Mid range		
Test Channel Bandwidths as specified in TS 38.508-1 [10] subclause 4.3.1		Lowest, Mid, Highest		
Test SCS as specified in Table 5.3.5-1		Lowest		
Test Parameters				
Test ID	**Downlink Configuration**		**Uplink Configuration**	
	Modulation	**RB allocation**	**Modulation**	**RB allocation**
1	CP-OFDM QPSK	NOTE 1	DFT-s-OFDM QPSK	NOTE 1
NOTE 1: The specific configuration of each RB allocation is defined in Table 7.3.2.4.1-1.				

1. Connection between SS and UE is shown in TS 38.508-1 [10] Annex A, Figure A.3.1.4.1 for TE diagram and section [TBD] for UE diagram.
2. The parameter settings for the cell are set up according to TS 38.508-1 [10] subclause 4.4.3.
3. Downlink signals are initially set up according to Annex [TBD], and uplink signals according to Annex [TBD].
4. The UL Reference Measurement channels are set according to Table 7.5.4.1-1.
5. Propagation conditions are set according to Annex B.0.
6. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity *NR*, Connected without release *On* according to TS 38.508-1 [10] clause 4.5. Message contents are defined in clause 6.5.1.4.3.

7.5.4.2 Test procedure

1. Set the UE in the Rx beam peak direction found with a 3D RSRP scan as performed in clause [TBD].
2. SS transmits PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to Table 7.5.4.1-1. The SS sends downlink MAC padding bits on the DL RMC.
3. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format [0_1] for C_RNTI to schedule the UL RMC according to Table 7.5.4.1-1. Since the UL has no payload data to send, the UE transmits uplink MAC padding bits on the UL RMC.
4. Set the Downlink signal level to the value as defined in Table 7.5.5-2 (Case 1). Send Uplink power control commands to the UE (less or equal to [TBD] dB step size should be used), to ensure that the UE output power is within [TBD] dB of the target power level in Table 7.5.5-2, for at least the duration of the Throughput measurement.
5. Set the interfering signal with the same AoA as the wanted signal, i.e. in the Rx beam peak direction for the UE as defined in step 1. Set the Interferer signal level to the value as defined in Table 7.5.5-2 (Case 1) and frequency below the wanted signal, using a modulated interferer bandwidth as defined in Annex [TBD].
6. Measure the average throughput for a duration sufficient to achieve statistical significance according to Annex H.2. Measure throughput per polarization is FFS.
7. Repeat steps from 4 to 6, using an interfering signal frequency above the wanted signal in Case 1 at step 5.
8. Set the Downlink signal level to the value as defined in Table 7.5.5-3 (Case 2). Send Uplink power control commands to the UE (less or equal to [TBD] dB step size should be used), to ensure that the UE output power is within [TBD] dB of the target power level in Table 7.5.5-3 , for at least the duration of the Throughput measurement.
9. Set the interfering signal with the same AoA as the wanted signal, i.e. in the Rx beam peak direction for the UE as defined in step 1. Set the Interferer signal level to the value as defined in Table 7.5.5-3 (Case 2) and frequency below the wanted signal, using a modulated interferer bandwidth as defined in Annex [TBD].

10. Measure the average throughput for a duration sufficient to achieve statistical significance according to Annex H.2. Measure throughput per polarization is FFS.

11. Repeat steps from 8 to 10, using an interfering signal above the wanted signal in Case 2 at step 9.

12. Repeat for applicable channel bandwidths and operating band combinations in both Case 1 and Case 2.

7.5.4.3 Message contents

Message contents are according to TS 38.508-1 [10] subclause 4.6 with DFT-s-OFDM condition in Table [4.6.3-n] PUSCH-Config.

7.5.5 Test requirements

The throughput measurement derived in test procedure shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annex A, under the conditions specified in Table 7.5.5-2 and also under the conditions specified in Table 7.5.5-3.

Table 7.5.5-1: Adjacent channel selectivity

		Channel bandwidth			
Rx Parameter	**Units**	**50 MHz**	**100 MHz**	**200 MHz**	**400 MHz**
ACS for band n257, n258, n261	dB	23	23	23	23
ACS for band n260	dB	22	22	22	22

Table 7.5.5-2: 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 + TT			
$P_{Interferer}$ 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 with one sided dynamic OCNG Pattern as described in Annex A.5.2.1 and set-up according to Annex C [].
NOTE 2: The REFSENS power level is specified in Table 7.3.2.3-1.
NOTE 3: The absolute value of the interferer offset $F_{Interferer}$ (offset) shall be further adjusted to $(\lceil |F_{Interferer}|/SCS \rceil + 0.5)SCS$ MHz with SCS the sub-carrier spacing of the wanted signal in MHz. Wanted and interferer signal have same SCS.

Table 7.5.5-3: 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 + TT	-46.5 + TT	-46.5 + TT	-46.5 + TT
Power in Transmission Bandwidth Configuration for band n260	dBm	-45.5 + TT	-45.5 + TT	-45.5 + TT	-45.5 + TT
$P_{Interferer}$	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 A with one sided dynamic OCNG Pattern TDD as described in Annex A.5.2.1 and set-up according to Annex C. NOTE 2: The absolute value of the interferer offset FInterferer (offset) shall be further adjusted to $(\lceil |F_{Interferer}|/SCS \rceil + 0.5)SCS$ MHz with SCS the sub-carrier spacing of the wanted signal in MHz. Wanted and interferer signal have same SCS.					

7.5A Adjacent channel selectivity for CA

FFS

7.5D Adjacent channel selectivity for UL-MIMO

FFS

7.6 Blocking characteristics

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.

7.6.1 General

FFS

7.6.2 In-band blocking

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

- Measurement uncertainty and test tolerances are FFS.
- UL power level configuration is TBD.
- Throughput calculation procedure is TBD (measurement period as well as dependencies with polarizations).
- Connection diagram for User Equipment part is FFS.

7.6.2.1 Test purpose

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.

7.6.2.2 Test applicability

This test applies to all types of NR UE release 15 and forward.

7.6.2.3 Minimum conformance requirements

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 Annexes 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 7.6.2.3-1: 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 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 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 centre of the aggregated CA bandwidth and the centre 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 centre frequencies.

The normative reference for this requirement is TS 38.101-2 [10] clause 7.6.2.

7.6.2.4 Test description

7.6.2.4.1 Initial conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

The initial test configurations consist of environmental conditions, test frequencies, test channel bandwidths and sub-carrier spacing based on NR operating bands specified in table 5.3.5-1. All of these configurations shall be tested with applicable test parameters for each combination of channel bandwidth and sub-carrier spacing, are shown in table 7.6.2.4.1-1. The details of the uplink reference measurement channels (RMC) are specified in Annexes A.2 and A.3.

Configuration of PDSCH and PDCCH before measurement are specified in Annex C.2. The details of the OCNG patterns used are specified in Annex A.5.

Table 7.6.2.4.1-1: Test Configuration Table

Initial Conditions				
Test Environment as specified in TS 38.508-1 [10] subclause 4.1		Normal		
Test Frequencies as specified in TS 38.508-1 [10] subclause 4.3.1		Mid range		
Test Channel Bandwidths as specified in TS 38.508-1 [10] subclause 4.3.1		Lowest, Mid, Highest		
Test SCS as specified in Table 5.3.5-1		Lowest		
Test Parameters				
Test ID	**Downlink Configuration**		**Uplink Configuration**	
	Modulation	**RB allocation**	**Modulation**	**RB allocation**
1	CP-OFDM QPSK	NOTE 1	DFT-s-OFDM QPSK	NOTE 1
NOTE 1: The specific configuration of each RB allocation is defined in Table 7.3.2.4.1-1.				

1. Connection between SS and UE is shown in TS 38.508-1 [10] Annex A, in Figure A.3.1.4.1 for TE diagram and section [TBD] for UE diagram.
2. The parameter settings for the cell are set up according to TS 38.508-1 [10] subclause 4.4.3.
3. Downlink signals are initially set up according to Annex [TBD], and uplink signals according to Annex [TBD].
4. The DL and UL Reference Measurement channels are set according to Table 7.6.2.4.1-1.
5. Propagation conditions are set according to Annex B.0.
6. Ensure the UE is in state RRC_CONNECTED with generic procedure parameters Connectivity *NR*, Connected without release *On* according to TS 38-508-1 [10] clause 4.5. Message content are defined in clause 7.6.2.4.3.

7.6.2.4.2 Test procedure

1. Set the UE in the Rx beam peak direction found with a 3D RSRP scan as performed in clause [TBD].
2. SS transmits PDSCH via PDCCH DCI format [1_1] for C_RNTI to transmit the DL RMC according to Table 7.6.2.4.1-1. The SS sends downlink MAC padding bits on the DL RMC.
3. SS sends uplink scheduling information for each UL HARQ process via PDCCH DCI format [0_1] for C_RNTI to schedule the UL RMC according to Table 7.6.2.4.1-1. Since the UL has no payload and no loopback data to send the UE sends uplink MAC padding bits on the UL RMC.
4. Set the interfering signal with the same AoA as the incident wave of the wanted signal, i.e. in the Rx beam peak direction for the UE as defined in step 1. Set the parameters of the signal generator for an interfering signal according to Table 7.6.2.5-1.
5. Set the downlink signal level according to the table 7.6.2.5-1. Send uplink power control commands to the UE (less or equal to TBD dB step size should be used), to ensure that the UE output power is within TBD dB of the target level in table 7.6.2.5-1, for at least the duration of the throughput measurement.
6. Measure the average throughput for a duration sufficient to achieve statistical significance according to Annex H.2. Measure throughput per polarization is FFS.
7. Repeat steps from 4 to 6, using interfering signals specified in 7.6.2.5-1. The ranges are covered in steps equal to the interferer bandwidth.

7.6.2.4.3 Message contents

Message contents are according to TS 38.508-1 [10] subclause 4.6 with DFT-s-OFDM condition in Table [4.6.3-n] PUSCH-Config.

7.6.2.5 Test requirement

The throughput measurement derived in test procedure shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annex A with parameters specified in Tables 7.6.2.5-1.

Table 7.6.2.5-1: In band blocking test requirement

Rx parameter	Units	Channel bandwidth			
		50 MHz	100 MHz	200 MHz	400 MHz
Power in Transmission Bandwidth Configuration	dBm	REFSENS + 14dB + TT			
$BW_{Interferer}$	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 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 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 centre of the aggregated CA bandwidth and the centre 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 centre frequencies.

7.6.3 Void

7.6A Blocking characteristics for CA

7.6A.1 General

FFS

7.6A.2 In-band blocking for CA

FFS

7.6D Blocking characteristics for UL-MIMO

FFS

7.7 Spurious response

FFS

7.8 Void

7.9 Spurious emissions

FFS

7.10 Receiver image

FFS

Annex A (normative): Measurement channels

A.1 General

TBD

A.2 UL reference measurement channels

A.2.1 General

TBD

A.2.2 Void

A.2.3 Reference measurement channels for TDD

TDD slot patterns defined for reference sensitivity tests and shown in Table A.2.3-1 will be used for UL RMCs defined below.

Table A.2.3-1 Additional reference channels parameters for TDD

Parameter		Value	
		SCS 60 kHz (μ=2)	SCS 120 kHz (μ=3)
UL-DL configuration	*referenceSubcarrierSpacing*	60 kHz	120 kHz
	dl-UL-TransmissionPeriodicity	2 ms	2 ms
	nrofDownlinkSlots	3	7
	nrofDownlinkSymbols	4	12
	nrofUplinkSlot	4	8
	nrofUplinkSymbols	4	0

A.2.3.1 DFT-s-OFDM Pi/2-BPSK

Table A.2.3.1-1: Reference Channels for DFT-s-OFDM pi/2-BPSK for 60kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	DFT-s-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size for slots with mod(slot index+1,5) = 0	Transport block CRC	LDPC Base Graph	Number of code blocks per slot for UL slots (Note 3, Note 4)	Total number of bits per slot for UL slots (Note 4)	Total modulated symbols per slot for UL slots (Note 4)
Unit	MHz	KHz						Bits	Bits			Bits	
	50-200	60	1	11	pi/2 BPSK	0	1/4	32	16	2	1	132	132
	50	60	32	11	pi/2 BPSK	0	1/4	1032	16	2	1	4224	4224
	50	60	64	11	pi/2 BPSK	0	1/4	2024	16	2	1	8448	8448
	100	60	64	11	pi/2 BPSK	0	1/4	2024	16	2	1	8448	8448
	100	60	128	11	pi/2 BPSK	0	1/4	3976	24	2	2	16896	16896
	200	60	128	11	pi/2 BPSK	0	1/4	3976	24	2	2	16896	16896
	200	60	256	11	pi/2 BPSK	0	1/4	7944	24	2	3	33792	33792

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM'ed] with PUSCH data.
Note 2: MCS Index is based on MCS Table 6.1.4.1-1 defined in TS 38.214 [23].
Note 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).
Note 4: UL slot numbers are given by the slots satisfying mod(slot index, 8) = {4,5,6,7} with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, UL slot numbers are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.

Table A.2.3.1-2: Reference Channels for DFT-s-OFDM pi/2-BPSK for 120kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	DFT-s-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size for slots with mod(slot index+1,5) = 0	Transport block CRC	LDPC Base Graph	Number of code blocks per slot for UL slots (Note 3, Note 4)	Total number of bits per slot for UL slots (Note 4)	Total modulated symbols per slot for UL slots (Note 4)
Unit	**MHz**	**KHz**						**Bits**	**Bits**			**Bits**	
	50-400	120	1	11	pi/2 BPSK	0	1/4	32	16	2	1	132	132
	50	120	16	11	pi/2 BPSK	0	1/4	504	16	2	1	2112	2112
	50	120	32	11	pi/2 BPSK	0	1/4	1032	16	2	1	4224	4224
	100	120	32	11	pi/2 BPSK	0	1/4	1032	16	2	1	4224	4224
	100	120	64	11	pi/2 BPSK	0	1/4	2024	16	2	1	8448	8448
	200	120	64	11	pi/2 BPSK	0	1/4	2024	16	2	1	8448	8448
	200	120	128	11	pi/2 BPSK	0	1/4	3976	24	2	2	16896	16896
	400	120	128	11	pi/2 BPSK	0	1/4	3976	24	2	2	16896	16896
	400	120	256	11	pi/2 BPSK	0	1/4	7944	24	2	3	33792	33792

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM'ed] with PUSCH data.

Note 2: MCS Index is based on MCS Table 6.1.4.1-1 defined in TS 38.214 [23].

Note 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).

Note 4: UL slot numbers are given by the slots satisfying mod(slot index, 16) = {8,…,15} with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, UL slot numbers are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.

A.2.3.2 DFT-s-OFDM QPSK

Table A.2.3.2-1: Reference Channels for DFT-s-OFDM QPSK for 60kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	DFT-s-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size for slots with mod(slot index+1,5) = 0	Transport block CRC	LDPC Base Graph	Number of code blocks per slot for UL slots (Note 3, Note 4)	Total number of bits per slot for UL slots (Note 4)	Total modulated symbols per slot for UL slots (Note 4)
Unit	MHz	KHz						Bits	Bits			Bits	
	50-200	60	1	11	QPSK	2	1/6	56	16	2	1	264	132
	50	60	32	11	QPSK	2	1/6	1608	16	2	1	8448	4224
	50	60	64	11	QPSK	2	1/6	3240	16	2	1	16896	8448
	100	60	64	11	QPSK	2	1/6	3240	16	2	1	16896	8448
	100	60	128	11	QPSK	2	1/6	6408	24	2	2	33792	16896
	200	60	128	11	QPSK	2	1/6	6408	24	2	2	33792	16896
	200	60	256	11	QPSK	2	1/6	12808	24	2	4	67584	33792

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM'ed] with PUSCH data.
Note 2: MCS Index is based on MCS Table 6.1.4.1-1 defined in TS 38.214 [23].
Note 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).
Note 4: UL slot numbers are given by the slots satisfying mod(slot index, 8) = {4,5,6,7} with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, UL slot numbers are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.

Table A.2.3.2-2: Reference Channels for DFT-s-OFDM QPSK for 120kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	DFT-s-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size for slots with mod(slot index+1,5) = 0	Transport block CRC	LDPC Base Graph	Number of code blocks per slot for UL slots (Note 3, Note 4)	Total number of bits per slot for UL slots (Note 4)	Total modulated symbols per slot for UL slots (Note 4)
Unit	MHz	KHz						Bits	Bits			Bits	
	50-400	120	1	11	QPSK	2	1/6	56	16	2	1	264	132
	50	120	16	11	QPSK	2	1/6	808	16	2	1	4224	2112
	50	120	32	11	QPSK	2	1/6	1608	16	2	1	8448	4224
	100	120	32	11	QPSK	2	1/6	1608	16	2	1	8448	4224
	100	120	64	11	QPSK	2	1/6	3240	16	2	1	16896	8448
	200	120	64	11	QPSK	2	1/6	3240	16	2	1	16896	8448
	200	120	128	11	QPSK	2	1/6	6408	24	2	2	33792	16896
	400	120	128	11	QPSK	2	1/6	6408	24	2	2	33792	16896
	400	120	256	11	QPSK	2	1/6	12808	24	2	4	67584	33792

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM'ed] with PUSCH data.

Note 2: MCS Index is based on MCS Table 6.1.4.1-1 defined in TS 38.214 [23].

Note 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).

Note 4: UL slot numbers are given by the slots satisfying mod(slot index, 16) = {8,…,15} with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, UL slot numbers are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.

A.2.3.3 DFT-s-OFDM 16QAM

Table A.2.3.3-1: Reference Channels for DFT-s-OFDM 16QAM for 60kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	DFT-s-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size for slots with mod(slot index+1,5) = 0	Transport block CRC	LDPC Base Graph	Number of code blocks per slot for UL slots (Note 3, Note 5)	Total number of bits per slot for UL slots (Note 5)	Total modulated symbols per slot for UL slots (Note 5)
Unit	MHz	KHz						Bits	Bits			Bits	
	50-200	60	1	11	16QAM	10	1/3	168	16	2	1	484	121
	50	60	32	11	16QAM	10	1/3	5376	24	1	1	16192	4048
	50	60	64	11	16QAM	10	1/3	10760	24	1	2	32384	8096
	100	60	64	11	16QAM	10	1/3	10760	24	1	2	32384	8096
	100	60	128	11	16QAM	10	1/3	21504	24	1	3	64768	16192
	200	60	128	11	16QAM	10	1/3	21504	24	1	3	64768	16192
	200	60	256	11	16QAM	10	1/3	43032	24	1	6	129536	32384

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM'ed] with PUSCH data.
Note 2: MCS Index is based on MCS Table 6.1.4.1-1 defined in TS 38.214 [23].
Note 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit.
Note 4: PTRS configuration is assumed to be (port 1, per 2PRB in frequency domain, per symbol in time domain). For TBS calculation, N-oh-prb = 6).
Note 5: UL slot numbers are given by the slots satisfying mod(slot index, 8) = {4,5,6,7} with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, UL slot numbers are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.

Table A.2.3.3-2: Reference Channels for DFT-s-OFDM 16QAM for 120kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	DFT-s-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size for slots with mod(slot index+1,5) = 0	Transport block CRC	LDPC Base Graph	Number of code blocks per slot for UL slots (Note 3, Note 5)	Total number of bits per slot for UL slots (Note 5)	Total modulated symbols per slot for UL slots (Note 5)
Unit	MHz	KHz						Bits	Bits			Bits	
	50-400	120	1	11	16QAM	10	1/3	168	16	2	1	484	121
	50	120	16	11	16QAM	10	1/3	2664	16	2	1	8096	2024
	50	120	32	11	16QAM	10	1/3	5376	24	1	1	16192	4048
	100	120	32	11	16QAM	10	1/3	5376	24	1	1	16192	4048
	100	120	64	11	16QAM	10	1/3	10760	24	1	2	32384	8096
	200	120	64	11	16QAM	10	1/3	10760	24	1	2	32384	8096
	200	120	128	11	16QAM	10	1/3	21504	24	1	3	64768	16192
	400	120	128	11	16QAM	10	1/3	21504	24	1	3	64768	16192
	400	120	256	11	16QAM	10	1/3	43032	24	1	6	129536	32384

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM'ed] with PUSCH data.
Note 2: MCS Index is based on MCS Table 6.1.4.1-1 defined in TS 38.214 [23].
Note 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit.
Note 4: PTRS configuration is assumed to be (port 1, per 2PRB in frequency domain, per symbol in time domain). For TBS calculation, N-oh-prb = 6).
Note 5: UL slot numbers are given by the slots satisfying mod(slot index, 16) = {8,…,15} with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, UL slot numbers are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.

A.2.3.4 DFT-s-OFDM 64QAM

Table A.2.3.4-1: Reference Channels for DFT-s-OFDM 64QAM for 60kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	DFT-s-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size for slots with mod(slot index+1,5) = 0	Transport block CRC	LDPC Base Graph	Number of code blocks per slot for UL slots (Note 3, Note 4)	Total number of bits per slot for UL slots (Note 4)	Total modulated symbols per slot for UL slots (Note 4)
Unit	MHz	KHz						Bits	Bits			Bits	
	50-200	60	1	11	64QAM	18	1/2	384	16	2	1	726	121
	50	60	32	11	64QAM	18	1/2	12296	24	1	2	24288	4048
	50	60	64	11	64QAM	18	1/2	24576	24	1	3	48576	8096
	100	60	64	11	64QAM	18	1/2	24576	24	1	3	48576	8096
	100	60	128	11	64QAM	18	1/2	49176	24	1	6	97152	16192
	200	60	128	11	64QAM	18	1/2	49176	24	1	6	97152	16192
	200	60	256	11	64QAM	18	1/2	98376	24	1	12	194304	32384

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM'ed] with PUSCH data.
Note 2: MCS Index is based on MCS Table 6.1.4.1-1 defined in TS 38.214 [23].
Note 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit.
Note 4: PTRS configuration is assumed to be (port 1, per 2PRB in frequency domain, per symbol in time domain). For TBS calculation, N-oh-prb = 6.)
Note 5: UL slot numbers are given by the slots satisfying mod(slot index, 8) = {4,5,6,7} with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, UL slot numbers are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.

Table A.2.3.4-2: Reference Channels for DFT-s-OFDM 64QAM for 120kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	DFT-s-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size for slots with mod(slot index+1,5) = 0	Transport block CRC	LDPC Base Graph	Number of code blocks per slot for UL slots (Note 3, Note 4)	Total number of bits per slot for UL slots (Note 4)	Total modulated symbols per slot for UL slots (Note 4)
Unit	MHz	KHz						Bits	Bits			Bits	
	50-400	120	1	11	64QAM	18	1/2	384	16	2	1	726	121
	50	120	16	11	64QAM	18	1/2	6144	24	1	1	12144	2024
	50	120	32	11	64QAM	18	1/2	12296	24	1	2	24288	4048
	100	120	32	11	64QAM	18	1/2	12296	24	1	2	24288	4048
	100	120	64	11	64QAM	18	1/2	24576	24	1	3	48576	8096
	200	120	64	11	64QAM	18	1/2	24576	24	1	3	48576	8096
	200	120	128	11	64QAM	18	1/2	49176	24	1	6	97152	16192
	400	120	128	11	64QAM	18	1/2	49176	24	1	6	97152	16192
	400	120	256	11	64QAM	18	1/2	98376	24	1	12	194304	32384

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM'ed] with PUSCH data.
Note 2: MCS Index is based on MCS Table 6.1.4.1-1 defined in TS 38.214 [23].
Note 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit.
Note 4: PTRS configuration is assumed to be (port 1, per 2PRB in frequency domain, per symbol in time domain). For TBS calculation, N-oh-prb = 6.)
Note 5: UL slot numbers are given by the slots satisfying mod(slot index, 16) = {8,…,15} with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, UL slot numbers are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.

A.2.3.5 CP-OFDM QPSK

Table A.2.3.5-1: Reference Channels for CP-OFDM QPSK for 60kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	CP-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size for slots with mod(slot index+1,5) = 0	Transport block CRC	LDPC Base Graph	Number of code blocks per slot for UL slots (Note 3, Note 4)	Total number of bits per slot for UL slots (Note 4)	Total modulated symbols per slot for UL slots (Note 4)
Unit	**MHz**	**KHz**						**Bits**	**Bits**			**Bits**	
	50-200	60	1	11	QPSK	2	1/6	56	16	2	1	264	132
	50	60	33	11	QPSK	2	1/6	1672	16	2	1	8712	4356
	50	60	66	11	QPSK	2	1/6	3368	16	2	1	17424	8712
	100	60	66	11	QPSK	2	1/6	3368	16	2	1	17424	8712
	100	60	132	11	QPSK	2	1/6	6536	24	2	2	34848	17424
	200	60	132	11	QPSK	2	1/6	6536	24	2	2	34848	17424
	200	60	264	11	QPSK	2	1/6	13064	24	2	4	69696	34848

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM'ed] with PUSCH data.
Note 2: MCS Index is based on MCS Table 5.1.3.1-1 defined in TS 38.214 [23].
Note 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit)
Note 4: UL slot numbers are given by the slots satisfying mod(slot index, 8) = {4,5,6,7} with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, UL slot numbers are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.

Table A.2.3.5-2: Reference Channels for CP-OFDM QPSK for 120kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	CP-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size for slots with mod(slot index+1,5) = 0	Transport block CRC	LDPC Base Graph	Number of code blocks per slot for UL slots (Note 3, Note 4)	Total number of bits per slot for UL slots (Note 4)	Total modulated symbols per slot for UL slots (Note 4)
Unit	**MHz**	**KHz**						**Bits**	**Bits**			**Bits**	
	50-400	120	1	11	QPSK	2	1/6	56	16	2	1	264	132
	50	120	16	11	QPSK	2	1/6	808	16	2	1	4224	2112
	50	120	32	11	QPSK	2	1/6	1608	16	2	1	8448	4224
	100	120	33	11	QPSK	2	1/6	1672	16	2	1	8712	4356
	100	120	66	11	QPSK	2	1/6	3368	16	2	1	17424	8712
	200	120	66	11	QPSK	2	1/6	3368	16	2	1	17424	8712
	200	120	132	11	QPSK	2	1/6	6536	24	2	2	34848	17424
	400	120	132	11	QPSK	2	1/6	6536	24	2	2	34848	17424
	400	120	264	11	QPSK	2	1/6	13064	24	2	4	69696	34848

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM'ed] with PUSCH data.
Note 2: MCS Index is based on MCS Table 5.1.3.1-1 defined in TS 38.214 [23].
Note 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit)
Note 4: UL slot numbers are given by the slots satisfying mod(slot index, 16) = {8,…,15} with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, UL slot numbers are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.

A.2.3.6 CP-OFDM 16QAM

Table A.2.3.6-1: Reference Channels for CP-OFDM 16QAM for 60kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	CP-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size for slots with mod(slot index+1,5) = 0	Transport block CRC	LDPC Base Graph	Number of code blocks per slot for UL slots (Note 3, Note 5)	Total number of bits per slot for UL slots (Note 5)	Total modulated symbols per slot for UL slots (Note 5)
Unit	MHz	KHz						Bits	Bits			Bits	
	50-200	60	1	11	16QAM	10	1/3	168	16	2	1	484	121
	50	60	33	11	16QAM	10	1/3	5504	24	1	1	16698	4174.5
	50	60	66	11	16QAM	10	1/3	11016	24	1	2	33396	8349
	100	60	66	11	16QAM	10	1/3	11016	24	1	2	33396	8349
	100	60	132	11	16QAM	10	1/3	22032	24	1	3	66792	16698
	200	60	132	11	16QAM	10	1/3	22032	24	1	3	66792	16698
	200	60	264	11	16QAM	10	1/3	44040	24	1	6	133584	33396

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM'ed] with PUSCH data.
Note 2: MCS Index is based on MCS Table 5.1.3.1-1 defined in TS 38.214 [23].
Note 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit.
Note 4: PTRS configuration is assumed to be (port 1, per 2PRB in frequency domain, per symbol in time domain). For TBS calculation, N-oh-prb = 6.)
Note 5: UL slot numbers are given by the slots satisfying mod(slot index, 8) = {4,5,6,7} with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, UL slot numbers are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.

Table A.2.3.6-2: Reference Channels for CP-OFDM 16QAM for 120kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	CP-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size for slots with mod(slot index+1,5) = 0	Transport block CRC	LDPC Base Graph	Number of code blocks per slot for UL slots (Note 3, Note 5)	Total number of bits per slot for UL slots (Note 5)	Total modulated symbols per slot for UL slots (Note 5)
Unit	MHz	KHz						Bits	Bits			Bits	
	50-400	120	1	11	16QAM	10	1/3	168	16	2	1	484	121
	50	120	16	11	16QAM	10	1/3	2664	16	2	1	8096	2024
	50	120	32	11	16QAM	10	1/3	5376	24	1	1	16192	4048
	100	120	33	11	16QAM	10	1/3	5504	24	1	1	16698	4174.5
	100	120	66	11	16QAM	10	1/3	11016	24	1	2	33396	8349
	200	120	66	11	16QAM	10	1/3	11016	24	1	2	33396	8349
	200	120	132	11	16QAM	10	1/3	22032	24	1	3	66792	16698
	400	120	132	11	16QAM	10	1/3	22032	24	1	3	66792	16698
	400	120	264	11	16QAM	10	1/3	44040	24	1	6	133584	33396

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM'ed] with PUSCH data.
Note 2: MCS Index is based on MCS Table 5.1.3.1-1 defined in TS 38.214 [23].
Note 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit.
Note 4: PTRS configuration is assumed to be (port 1, per 2PRB in frequency domain, per symbol in time domain). For TBS calculation, N-oh-prb = 6.)
Note 5: UL slot numbers are given by the slots satisfying mod(slot index, 16) = {8,…,15} with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, UL slot numbers are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.

A.2.3.7 CP-OFDM 64QAM

Table A.2.3.7-1: Reference Channels for CP-OFDM 64QAM for 60kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	CP-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size for slots with mod(slot index+1,5) = 0	Transport block CRC	LDPC Base Graph	Number of code blocks per slot for UL slots (Note 3, Note 5)	Total number of bits per slot for UL slots (Note 5)	Total modulated symbols per slot for UL slots (Note 5)
Unit	MHz	KHz						Bits	Bits			Bits	
	50-200	60	1	11	64QAM	19	1/2	384	16	2	1	726	121
	50	60	33	11	64QAM	19	1/2	12552	24	1	2	25047	4174.5
	50	60	66	11	64QAM	19	1/2	25104	24	1	3	50094	8349
	100	60	66	11	64QAM	19	1/2	25104	24	1	3	50094	8349
	100	60	132	11	64QAM	19	1/2	50184	24	1	6	100188	16698
	200	60	132	11	64QAM	19	1/2	50184	24	1	6	100188	16698
	200	60	264	11	64QAM	19	1/2	100392	24	1	12	200376	33396

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM'ed] with PUSCH data.
Note 2: MCS Index is based on MCS Table 5.1.3.1-1 defined in TS 38.214 [23].
Note 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit.
Note 4: PTRS configuration is assumed to be (port 1, per 2PRB in frequency domain, per symbol in time domain). For TBS calculation, N-oh-prb = 6.)
Note 5: UL slot numbers are given by the slots satisfying mod(slot index, 8) = {4,5,6,7} with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, UL slot numbers are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.

Table A.2.3.7-2: Reference Channels for CP-OFDM 64QAM for 120kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	CP-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size for slots with mod(slot index+1,5) = 0	Transport block CRC	LDPC Base Graph	Number of code blocks per slot for UL slots (Note 3, Note 5)	Total number of bits per slot for UL slots (Note 5)	Total modulated symbols per slot for UL slots (Note 5)
Unit	MHz	KHz						Bits	Bits			Bits	
	50-400	120	1	11	64QAM	19	1/2	384	16	2	1	726	121
	50	120	16	11	64QAM	19	1/2	6144	24	1	1	12144	2024
	50	120	32	11	64QAM	19	1/2	12296	24	1	2	24288	4048
	100	120	33	11	64QAM	19	1/2	12552	24	1	2	25047	4174.5
	100	120	66	11	64QAM	19	1/2	25104	24	1	3	50094	8349
	200	120	66	11	64QAM	19	1/2	25104	24	1	3	50094	8349
	200	120	132	11	64QAM	19	1/2	50184	24	1	6	100188	16698
	400	120	132	11	64QAM	19	1/2	50184	24	1	6	100188	16698
	400	120	264	11	64QAM	19	1/2	100392	24	1	12	200376	33396

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM'ed] with PUSCH data.
Note 2: MCS Index is based on MCS Table 5.1.3.1-1 defined in TS 38.214 [23].
Note 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit.
Note 4: PTRS configuration is assumed to be (port 1, per 2PRB in frequency domain, per symbol in time domain). For TBS calculation, N-oh-prb = 6.).
Note 5: UL slot numbers are given by the slots satisfying mod(slot index, 16) = {8,…,15} with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, UL slot numbers are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.

A.3 DL reference measurement channels

A.3.1 General

Unless otherwise stated, Tables A.3.3.2-1 and A.3.3.2-2 are applicable for measurements of the Receiver Characteristics (clause 7).

Unless otherwise stated, Tables A.3.3.2-1 and A.3.3.2-2 also apply for the modulated interferer used in Clauses 7.5 and 7.6 with test specific bandwidths.

Table A.3.1-1 Test parameters

Parameter	Unit	Value
CORESET frequency domain allocation		Full BW
CORESET time domain allocation		2 OFDM symbols at the begin of each slot
PDSCH mapping type		Type A
PDSCH start symbol index (S)		2
Number of consecutive PDSCH symbols (L)		12
PDSCH PRB bundling	PRBs	2
Dynamic PRB bundling		false
MCS table for TBS determination		64QAM
Overhead value for TBS determination		0
First DMRS position for Type A PDSCH mapping		2
DMRS type		Type 1
Number of additional DMRS		2
FDM between DMRS and PDSCH		Disable
TRS configuration		1 slot, periodicity 10 ms, offset 0
PTRS configuration		PTRS is not configured

A.3.2 Void

A.3.3 DL reference measurement channels for TDD

A.3.3.1 General

Table A.3.3.1-1: Additional test parameters for TDD

Parameter		Value	
		SCS 60 kHz (μ=2)	**SCS 120 kHz (μ=3)**
UL-DL configuration	*referenceSubcarrierSpacing*	60 kHz	120 kHz
	dl-UL-TransmissionPeriodicity	1.25 ms	0.625 ms
	nrofDownlinkSlots	3	3
	nrofDownlinkSymbols	4	10
	nrofUplinkSlot	1	1
	nrofUplinkSymbols	4	2
Number of HARQ Processes		8	8
K1 value		K1 = 4 if mod(i,5) = 0 K1 =3 if mod(i,5) = 1 K1 =2 if mod(i,5) = 2 where i is slot index per frame; i = {0,…,39}	K1 = 4 if mod(i,5) = 0 K1 =3 if mod(i,5) = 1 K1 =2 if mod(i,5) = 2 where i is slot index per frame; i = {0,…,79}

A.3.3.2 FRC for receiver requirements for QPSK

Table A.3.3.2-1: Fixed Reference Channel for Receiver Requirements (SCS 60 kHz, TDD)

Parameter	Unit	Value		
Channel bandwidth	MHz	50	100	200
Subcarrier spacing configuration μ		2	2	2
Allocated resource blocks		66	132	264
Subcarriers per resource block		12	12	12
Allocated slots per Frame		23	23	23
MCS index		4	4	4
Modulation		QPSK	QPSK	QPSK
Target Coding Rate		1/3	1/3	1/3
Maximum number of HARQ transmissions		1	1	1
Information Bit Payload per Slot				
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,39}	Bits	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {0,1,2} for i from {1,…,39}	Bits	4224	8456	16896
Transport block CRC	Bits	24	24	24
LDPC base graph		1	1	1
Number of Code Blocks per Slot				
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,39}	CBs	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {0,1,2} for i from {1,…,39}	CBs	1	2	2
Binary Channel Bits Per Slot				
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,39}	Bits	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {0,1,2} for i from {1,…,39}	Bits	14256	28512	57024
Max. Throughput averaged over 1 frame	Mbps	9.715	19.449	38.861
Note 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.3.1-1. Note 2: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit). Note 3: SS/PBCH block is transmitted in slot 0 of each frame Note 4: Slot i is slot index per frame				

Table A.3.3.2-2: Fixed Reference Channel for Receiver Requirements (SCS 120 kHz, TDD)

Parameter	Unit	Value			
Channel bandwidth	MHz	50	100	200	400
Subcarrier spacing configuration μ		3	3	3	3
Allocated resource blocks		32	66	132	264
Subcarriers per resource block		12	12	12	12
Allocated slots per Frame		47	47	47	47
MCS index		4	4	4	4
Modulation		QPSK	QPSK	QPSK	QPSK
Target Coding Rate		1/3	1/3	1/3	1/3
Maximum number of HARQ transmissions		1	1	1	1
Information Bit Payload per Slot					
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,79}	Bits	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79}	Bits	2088	4224	8456	16896
Transport block CRC	Bits	16	24	24	24
LDPC base graph		2	1	1	1
Number of Code Blocks per Slot					
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,79}	CBs	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79}	CBs	1	1	2	2
Binary Channel Bits Per Slot					
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,79}	Bits	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79}	Bits	6912	14256	28512	57024
Max. Throughput averaged over 1 frame	Mbps	9.814	19.853	39.743	79.411
Note 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.3.1-1. Note 2: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit). Note 3: SS/PBCH block is transmitted in slot 0 of each frame Note 4: Slot i is slot index per frame					

A.4 Void

A.5 OFDMA Channel Noise Generator (OCNG)

A.5.1 OCNG Patterns for FDD

TBD

A.5.2 OCNG Patterns for TDD

A.5.2.1 OCNG TDD pattern 1: Generic OCNG TDD Pattern for all unused REs

Table A.5.2.1-1: OP.1 TDD: Generic OCNG TDD Pattern for all unused REs

OCNG Distribution / OCNG Parameters	Control Region (Core Set)	Data Region
Resources allocated	All unused REs (Note 1)	All unused REs (Note 2)
Structure	PDCCH	PDSCH
Content	Uncorrelated pseudo random QPSK modulated data	Uncorrelated pseudo random QPSK modulated data
Transmission scheme for multiple antennas ports transmission	Single Tx port transmission	Spatial multiplexing using any precoding matrix with dimensions same as the precoding matrix for PDSCH
Subcarrier Spacing	Same as for RMC PDCCH in the active BWP	Same as for RMC PDSCH in the active BWP
Power Level	Same as for RMC PDCCH	Same as for RMC PDSCH
Note 1: All unused REs in the active CORESETS appointed by the search spaces in use. Note 2: Unused available REs refer to REs in PRBs not allocated for any physical channels, CORESETs, synchronization signals or reference signals in channel bandwidth.		

Annex B (normative): Propagation conditions

B.0 No interference

The downlink connection between the System Simulator and the UE is without Additive White Gaussian Noise, and has no fading or multipath effects.

Annex C (normative): Downlink Physical Channels

C.0 Downlink signal levels

Editor's Note : Consideration to minimize the required number of additional FR2 link is under discussion

The downlink power settings in Table C.0-1 is used unless otherwise specified in a test case.

Table C.0-1: Default Downlink power levels for NR

SCS (kHz)		Unit	Channel Bandwidth			
			50 MHz	100 MHz	200 MHz	400 MHz
60	Number of RBs		66	132	264	N/A
	Channel BW power	dBm	-70	-67	-64	N/A
120	Number of RBs		32	66	132	264
	Channel BW power	dBm	-70	-67	-64	-61
	SS/PBCH SSS EPRE	dBm/60kHz	[-99]	[-99]	[-99]	[-99]

Note 1: The channel bandwidth powers are informative, based on [-99]dBm/60kHz SS/PBCH SSS EPRE, then scaled according to the number of RBs and rounded to the nearest integer dBm value. Full RE allocation with no boost or deboost is assumed.
Note 2: The power level is specified at the centre of quiet zone.
Note 3: DL level is applied for any of the Subcarrier Spacing configuration (μ) with the same power spectrum density of [–99]dBm/60kHz.

The default downlink signal level uncertainty is +/- TBD dB, for any level specified. If the uncertainty value is critical for the test purpose, a tighter uncertainty is specified for the related test case in Annex F.

For TRP measurement, DL signal may be supplied from RSRP based pathloss compensation link. Downlink signal level using RSRP based pathloss compensation link is specified in Table C.0-2 or Table C.0-3.

Table C.0-2: Downlink power levels for RSRP based pathloss compensation link for TRP measurement for n257, n258 and n260

SCS (kHz)		Unit	Channel Bandwidth			
			50 MHz	100 MHz	200 MHz	400 MHz
60	Number of RBs		66	132	264	N/A
	Channel BW power	dBm	≥ -87	≥ -84	≥ -80	N/A
120	Number of RBs		32	66	132	264
	Channel BW power	dBm	≥ -87	≥ -84	≥ -80	≥ -77
	SS/PBCH SSS EPRE	dBm/60kHz	≥ -115.5	≥ -115.5	≥ -115.5	≥ -115.5

Note 1: The channel bandwidth powers are informative, based on -115.5dBm/60kHz SS/PBCH SSS EPRE, then scaled according to the number of RBs and rounded to the nearest integer dBm value. Full RE allocation with no boost or deboost is assumed.
Note 2: The power level is specified at the RSRP reference point as defined in TS 38.215 [24].
Note 3: DL level is applied for any of the Subcarrier Spacing configuration (μ) with the same power spectrum density of ≥ –115.5 dBm/60kHz.

Table C.0-3: Downlink power levels for RSRP based pathloss compensation link for TRP measurement for n261

SCS (kHz)		Unit	Channel Bandwidth			
			50 MHz	100 MHz	200 MHz	400 MHz
60	Number of RBs		66	132	264	N/A
	Channel BW power	dBm	≥ -84	≥ -81	≥ -78	N/A
120	Number of RBs		32	66	132	264
	Channel BW power	dBm	≥ -84	≥ -81	≥ -78	≥ -75
	SS/PBCH SSS EPRE	dBm/60kHz	≥ -113	≥ -113	≥ -113	≥ -113

Note 1: The channel bandwidth powers are informative, based on -113dBm/60kHz SS/PBCH SSS EPRE, then scaled according to the number of RBs and rounded to the nearest integer dBm value. Full RE allocation with no boost or deboost is assumed.
Note 2: The power level is specified at the RSRP reference point as defined in TS 38.215 [24].
Note 3: DL level is applied for any of the Subcarrier Spacing configuration (μ) with the same power spectrum density of ≥ –113 dBm/60kHz.

C.1 General

The following clauses describes the downlink Physical Channels that are transmitted during a connection i.e., when measurements are done.

C.2 Setup

Table C.2-1 describes the downlink Physical Channels that are required for connection set up.

Table C.2-1: Downlink Physical Channels required for connection set-up

Physical Channel
PBCH
SSS
PSS
PDCCH
PDSCH
PBCH DMRS
PDCCH DMRS
PDSCH DMRS
CSI-RS
PTRS

C.3 Connection

C.3.0 Measurement of Transmitter Characteristics

Unless otherwise stated, Table C.3.0-1 is applicable for measurements on the Transmitter Characteristics (clause 6).

Table C.3.0-1: Downlink Physical Channels transmitted during a connection (TDD)

Parameter	Unit	Value
SSS transmit power	W	Test specific
EPRE ratio of PSS to SSS	dB	0
EPRE ratio of PBCH DMRS to SSS	dB	0
EPRE ratio of PBCH to PBCH DMRS	dB	0
EPRE ratio of PDCCH DMRS to SSS	dB	0
EPRE ratio of PDCCH to PDCCH DMRS	dB	0
EPRE ratio of PDSCH DMRS to SSS (Note 1)	dB	3
EPRE ratio of PDSCH to PDSCH DMRS (Note 1)	dB	-3
EPRE ratio of CSI-RS to SSS	dB	0
EPRE ratio of PTRS to PDSCH	dB	Test specific
EPRE ratio of OCNG DMRS to SSS	dB	0
EPRE ratio of OCNG to OCNG DMRS (Note 1)	dB	0
Note 1: No boosting is applied to any of the channels except PDSCH DMRS. For PDSCH DMRS, 3 dB power boosting is applied assuming DMRS Type 1 configuration when DMRS and PDSCH are TDM'ed and only half of the DMRS REs are occupied. Note 2: Number of DMRS CDM groups without data for PDSCH DMRS configuration for OCNG is set to 1.		

C.3.1 Measurement of Receiver Characteristics

Unless otherwise stated, Table C.3.1-1 is applicable for measurements on the Receiver Characteristics (clause 7).

Table C.3.1-1: Downlink Physical Channels transmitted during a connection (TDD)

Parameter	Unit	Value
SSS transmit power	W	Test specific
EPRE ratio of PSS to SSS	dB	0
EPRE ratio of PBCH DMRS to SSS	dB	0
EPRE ratio of PBCH to PBCH DMRS	dB	0
EPRE ratio of PDCCH DMRS to SSS	dB	0
EPRE ratio of PDCCH to PDCCH DMRS	dB	0
EPRE ratio of PDSCH DMRS to SSS (Note 1)	dB	3
EPRE ratio of PDSCH to PDSCH DMRS (Note 1)	dB	-3
EPRE ratio of CSI-RS to SSS	dB	0
EPRE ratio of PTRS to PDSCH	dB	Test specific
EPRE ratio of OCNG DMRS to SSS	dB	0
EPRE ratio of OCNG to OCNG DMRS (Note 1)	dB	0
Note 1: No boosting is applied to any of the channels except PDSCH DMRS. For PDSCH DMRS, 3 dB power boosting is applied assuming DMRS Type 1 configuration when DMRS and PDSCH are TDM'ed and only half of the DMRS REs are occupied. Note 2: Number of DMRS CDM groups without data for PDSCH DMRS configuration for OCNG is set to 1.		

Annex D (normative): Characteristics of the interfering signal

Detailed content of the annex is TBD.

Annex E (normative): Global In-Channel TX-Test

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

Number of preamble sequences over which EVM_{PRACH} is averaged is TBD in TS 38.101-2.NOTE: Clauses E.2.2 to E.5.9.3 are descriptions, which assume no power ramping adjacent to the measurement period.

E.1 General

The global in-channel TX test enables the measurement of all relevant parameters that describe the in-channel quality of the output signal of the TX under test in a single measurement process.

The parameters describing the in-channel quality of a transmitter, however, are not necessarily independent. The algorithm chosen for description inside this annex places particular emphasis on the exclusion of all interdependencies among the parameters.

E.2 Signals and results

E.2.1 Basic principle

The process is based on the comparison of the actual **output signal of the TX under test**, received by an ideal receiver, with a **reference signal**, that is generated by the measuring equipment and represents an ideal error free received signal. All signals are represented as equivalent (generally complex) baseband signals.

The description below uses numbers as examples. These numbers are taken from TDD with normal CP length and 100 MHz bandwidth with 60 kHz SCS. The application of the text below, however, is not restricted to this frame structure and bandwidth.

E.2.2 Output signal of the TX under test

The output signal of the TX under test is acquired by the measuring equipment and stored for further processing. It is sampled at a sampling rate of 122.88 Mbps. In the time domain it comprises at least 10 uplink subframes. The measurement period is derived by concatenating the correct number of individual uplink slots until the correct measurement period is reached. The output signal is named z(ν). Each slot is modelled as a signal with the following parameters: demodulated data content, carrier frequency, amplitude and phase for each subcarrier, timing, carrier leakage.

NOTE 1: TDD

Since the uplink subframes are not continuous, the *n* slots should be extracted from more than 1 continuous radio frame where

$$n = \begin{cases} 30, \text{ for 60 kHz SCS} \\ 60, \text{ for 120 kHz SCS} \end{cases}.$$

E.2.3 Reference signal

Two types of reference signal are defined:

The reference signal $i_1(\nu)$ is constructed by the measuring equipment according to the relevant TX specifications, using the following parameters: demodulated data content, nominal carrier frequency, nominal amplitude and phase for each subcarrier, nominal timing, no carrier leakage. It is represented as a sequence of samples at a sampling rate of 122.88 Mbps in the time domain.

The reference signal $i_2(\nu)$ is constructed by the measuring equipment according to the relevant TX specifications, using the following parameters: restricted data content: nominal reference symbols, (all modulation symbols for user data symbols are set to 0V), nominal carrier frequency, nominal amplitude and phase for each applicable subcarrier, nominal timing, no carrier leakage. It is represented as a sequence of samples at a sampling rate of 122.88 Mbps in the time domain.

NOTE: The PUCCH is off during the time under test.

E.2.4 Measurement results

The measurement results, achieved by the global in channel TX test are the following:

- Carrier Frequency error
- EVM (Error Vector Magnitude)
- Carrier leakage
- Unwanted emissions, falling into non allocated resource blocks.
- EVM equalizer spectrum flatness

E.2.5 Measurement points

The unwanted emission falling into non-allocated RB(s) is calculated directly after the FFT as described below. In contrast to this, the EVM for the allocated RB(s) is calculated after the IDFT for DFT-s-OFDM or after the Tx-Rx chain equalizer for CP-OFDM. The samples after the TX-RX chain equalizer are used to calculate EVM equalizer spectrum flatness. Carrier frequency error and carrier leakage is calculated in the block "RF correction".

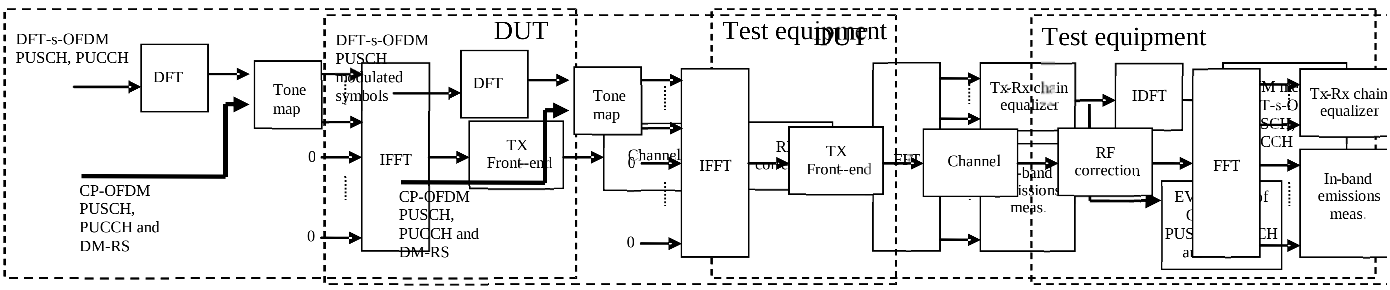

Figure E.2.5-1: EVM measurement points

E.3 Signal processing

E.3.1 Pre FFT minimization process

Before applying the pre-FFT minimization process, z(ν) and i(ν) are portioned into *n* pieces, comprising one slot each, where

$$n = \begin{cases} 30, \text{ for 60 kHz SCS} \\ 60, \text{ for 120 kHz SCS} \end{cases}.$$

Each slot is processed separately. Sample timing, Carrier frequency and carrier leakage in z(ν) are jointly varied in order to minimise the difference between z(ν) and i(ν). Best fit (minimum difference) is achieved when the RMS difference value between z(ν) and i(ν) is an absolute minimum.

The carrier frequency variation and the IQ variation are the measurement results: Carrier Frequency Error and Carrier leakage.

From the acquired samples *n* carrier frequencies and *n* carrier leakages can be derived.

NOTE 1: The minimisation process, to derive carrier leakage and RF error can be supported by Post FFT operations. However the minimisation process defined in the pre FFT domain comprises all acquired samples (i.e. it does not exclude the samples in between the FFT widths and it does not exclude the bandwidth outside the transmission bandwidth configuration

NOTE 2: The algorithm would allow deriving Carrier Frequency error and Sample Frequency error of the TX under test separately. However there are no requirements for Sample Frequency error. Hence the algorithm models the RF and the sample frequency commonly (not independently). It returns one error and does not distinguish between both.

After this process the samples z(ν) are called $z^0(\nu)$.

E.3.2 Timing of the FFT window

The FFT window length is 2048 samples per OFDM symbol. 14 FFTs (28672 samples) cover less than the acquired number of samples (30720 samples). The position in time for FFT must be determined.

In an ideal signal, the FFT may start at any instant within the cyclic prefix without causing an error. The TX filter, however, reduces the window. The EVM requirements shall be met within a window W<CP. There are three different instants for FFT:

Centre of the reduced window, called $\Delta\tilde{c}$, $\Delta\tilde{c}$ –W/2 and $\Delta\tilde{c}$ +W/2.

The timing of the measured signal is determined in the pre FFT domain as follows, using $z^0(\nu)$ and $i_2(\nu)$:

1. The measured signal is delay spread by the TX filter. Hence the distinct boarders between the OFDM symbols and between Data and CP are also spread and the timing is not obvious.

2. In the Reference Signal $i_2(\nu)$ the timing is known.

3. Correlation between (1.) and (2.) will result in a correlation peak. The meaning of the correlation peak is approx. the “impulse response” of the TX filter. The meaning of “impulse response” assumes that the autocorrelation of the reference signal $i_2(\nu)$ is a Dirac peak and that the correlation between the reference signal $i_2(\nu)$ and the data in the measured signal is 0. The correlation peak, (the highest, or in case of more than one, the earliest) indicates the timing in the measured signal.

From the acquired samples, *n* timings can be derived.

For all calculations, except EVM, the number of samples in $z^0(\nu)$ is reduced to 14 blocks of samples, comprising 2048 samples (FFT width) and starting with $\Delta\tilde{c}$ in each OFDM symbol including the demodulation reference signal.

For the EVM calculation the output signal under test is reduced to 28 blocks of samples, comprising 2048 samples (FFT width) and starting with $\Delta\tilde{c}$ –W/2 and $\Delta\tilde{c}$ +W/2 in each OFDM symbol including the demodulation reference signal.

The number of samples, used for FFT is reduced compared to $z^0(\nu)$. This subset of samples is called z’(ν).

The timing of the centre $\Delta\tilde{c}$ with respect to the different CP length in a slot is as follows: (TDD, normal CP length)

$\Delta\tilde{c}$ is on T_f=72 (=CP/2) within the CP of length 144 FFT samples (in OFDM symbols except 0 and 28 (=$7 \cdot 2^{\mu}$), where symbol 0 is the first symbol of each subframe) for channel bandwidth of 100 MHz and SCS = 60 kHz.

$\Delta\tilde{c}$ is on T_f=88 (=160-72) within the CP of length 160 FFT samples (in OFDM symbol 0 and 28 (=$7 \cdot 2^{\mu}$), where symbol 0 is the first symbol of each subframe) for channel bandwidth of 100 MHz and SCS = 60 kHz.

E.3.3 Post FFT equalisation

Perform 14 FFTs on z’(ν), one for each OFDM symbol in a slot using the timing $\Delta\tilde{c}$, including the demodulation reference symbol. The result is an array of samples, 14 in the time axis t times 2048 in the frequency axis f. The samples represent the data symbols (in OFDM-symbol 0,1,3,4,5,6,8,9,10,12,13 in each slot) and demodulation reference symbols (OFDM symbol 2, 7, 11 in each slot) in the allocated RBs and inband emissions in the non allocated RBs within the transmission BW.

Only the allocated resource blocks in the frequency domain are used for equalisation.

The nominal demodulation reference symbols and nominal data symbols are used to equalize the measured data symbols. (Location for equalization see Figure E.2.5-1)

NOTE: The nomenclature inside this note is local and not valid outside.

The nominal data symbols are created by a demodulation process. The location to gain the demodulated data symbols is "EVM" in Figure E.2.5-1. For CP-OFDM, the process described in Annex E.5 can be applied. A demodulation process as follows is recommended for DFT-s-OFDM:

1. Equalize the measured data symbols using the reference symbols for equalisation. Result: Equalized data symbols
2. Only for DFT-s-OFDM, iDFT transform the equalized data symbols: Result: Equalized data symbols
3. Decide for the nearest constellation point: Result: Nominal data symbols
4. Only for DFT-s-OFDM, DFT transform the nominal data symbols: Result: Nominal data symbols

At this stage we have an array of Measured data-Symbols and reference-Symbols (MS(f,t))

versus an array of Nominal data-Symbols and reference Symbols (NS(f,t))

(complex, the arrays comprise 11 data symbols and 3 demodulation reference symbol in the time axis and the number of allocated subcarriers in the frequency axis.)

MS(f,t) and NS(f,t) are processed with a least square (LS) estimator, to derive one equalizer coefficient per time slot and per allocated subcarrier. EC(f) is defined as

$$EC(f) = \frac{\sum_{t=0}^{13} NS(f,t)^* NS(f,t)}{\sum_{t=0}^{13} NS(f,t)^* MS(f,t)}.$$

With * denoting complex conjugation.

EC(f) are used to equalize the DFT-coded data symbols. The measured DFT-coded data and the references symbols are equalized by:

$$Z'(f,t) = MS(f,t) \cdot EC(f)$$

With · denoting multiplication.

Z'(f,t), restricted to the data symbol (excluding t=2,7,11) is used to calculate EVM, as described in E.4.1.

EC(f) is used in E.4.4 to calculate EVM equalizer spectral flatness.

NOTE: The post FFT minimisation process is done over 14 symbols (11 DFT-coded data symbols and 3 reference symbols).

The samples of the non allocated resource blocks within the transmission bandwidth configuration in the post FFT domain are called Y(f,t) (f covering the non allocated subcarriers within the transmission bandwidth configuration, t covering the OFDM symbols during 1 slot).

E.4 Derivation of the results

E.4.1 EVM

For EVM create two sets of Z'(f,t)., according to the timing " $\Delta\tilde{c}$ –W/2 and $\Delta\tilde{c}$ +W/2" using the equalizer coefficients from E.3.3.

Perform the iDFTs on Z'(f,t) in the case of DFT-s-OFDM waveform. The IDFT-decoding preserves the meaning of t but transforms the variable f (representing the allocated sub carriers) into another variable g, covering the same count and representing the demodulated symbols. The samples in the post IDFT domain are called iZ'(g, t). The equivalent ideal samples are called iI(g,t). Those samples of Z'(f,t), carrying the reference symbols (=symbol 2,7,11) are not iDFT processed.

The EVM is the difference between the ideal waveform and the measured and equalized waveform for the allocated RB(s)

$$EVM = \sqrt{\frac{\sum_{t \in T} \sum_{g \in G} \left| iZ'(g,t) - iI(g,t) \right|^2}{|G| \cdot |T| \cdot P_0}} ,$$

where

t covers the count of demodulated symbols with the considered modulation scheme being active within the measurement period, (i.e. symbol 0,1,3,4,5,6,8,9,10,12,13 in each slot, →|T|=11)

g covers the count of demodulated symbols with the considered modulation scheme being active within the allocated bandwidth. (|G|=12* L_{CRBs} (with L_{CRBs} : number of allocated resource blocks)).

$iZ'(g,t)$ are the samples of the signal evaluated for the EVM.

$iI(g,t)$ is the ideal signal reconstructed by the measurement equipment, and

P_0 is the average power of the ideal signal. For normalized modulation symbols P_0 is equal to 1.

From the acquired samples 2n EVM values can be derived, n values for the timing $\Delta\tilde{c}$ –W/2 and n values for the timing $\Delta\tilde{c}$ +W/2

E.4.2 Averaged EVM

EVM is averaged over all basic EVM measurements.

The averaging comprises n UL slots

$$\overline{EVM} = \sqrt{\frac{1}{n}\sum_{i=1}^{n} EVM_i^2}$$

where

$$n = \begin{cases} 30, \text{ for 60 kHz SCS} \\ 60, \text{ for 120 kHz SCS} \end{cases}$$

for PUCCH, PUSCH.

The averaging is done separately for timing $\Delta\tilde{c}$ –W/2 and $\Delta\tilde{c}$ +W/2 leading to $\overline{\mathrm{EVM}}_l$ and $\overline{\mathrm{EVM}}_h$

$EVM_{final} = \max(\overline{\mathrm{EVM}}_l, \overline{\mathrm{EVM}}_h)$ is compared against the test requirements.

E.4.3 In-band emissions measurement

The in-band emissions are a measure of the interference falling into the non-allocated resources blocks.

Explanatory Note:

The inband emission measurement is only meaningful with allocated RB(s) next to non allocated RB. The allocated RB(s) are necessary but not under test. The non allocated RBs are under test. The RB allocation for this test is as follows: The allocated RB(s) are at one end of the channel BW, leaving the other end unallocated. The number of allocated RB(s) is smaller than half of the number of RBs, available in the channel BW. This means that the vicinity of the carrier in the centre is unallocated.

There are 3 types of inband emissions:

1. General

2. IQ image
3. Carrier leakage

Carrier leakage are inband emissions next to the carrier.

IQ image are inband emissions symmetrically (with respect to the carrier) on the other side of the allocated RBs.

General are applied to all unallocated RBs.

For each evaluated RB, the minimum requirement is calculated as the higher of P_{RB} - 30 dB and the power sum of all limit values (General, IQ Image or Carrier leakage) that apply.

In specific the following combinations:

- Power (General)
- Power (General + Carrier leakage)
- Power (General + IQ Image)

  1 and 2 is expressed in terms of power in one non allocated RB under test, normalized to the average power of an allocated RB (unit dB).

  3 is expressed in terms of power in one non allocated RB, normalized to the power of all allocated RBs. (unit dBc).

This is the reason for two formulas *Emissions* $_{relative}$.

Create one set of Y(t,f) per slot according to the timing " $\Delta\tilde{c}$ "

For the non-allocated RBs below the in-band emissions are calculated as follows

$$Emissions_{absolute}(\Delta_{RB}) = \begin{cases} \dfrac{1}{|T_s|}\sum_{t\in T_s}\sum_{\max(f_{\min},(c_l+12\cdot\Delta_{RB}*\Delta f))}^{c_l+(12\cdot\Delta_{RB}+11)*\Delta f}|Y(t,f)|^2, \Delta_{RB}<0 \\ \dfrac{1}{|T_s|}\sum_{t\in T_s}\sum_{c_h+(12\cdot\Delta_{RB}-11)*\Delta f}^{\min(f_{\max},(c_h+12\cdot\Delta_{RB}*\Delta f))}|Y(t,f)|^2, \Delta_{RB}>0 \end{cases},$$

where

the upper formula represents the in band emissions below the allocated frequency block and the lower one the in band emissions above the allocated frequency block.

T_s is a set of $|T_s|$ DFT-s-OFDM symbols with the considered modulation scheme being active within the measurement period,

Δ_{RB} is the starting frequency offset between the allocated RB and the measured non-allocated RB (e.g. $\Delta_{RB}=1$ for the first upper or $\Delta_{RB}=-1$ for the first lower adjacent RB),

$f_{\min}$ and $f_{\max}$ are the lower and upper edge of the UL transmission BW configuration,

c_l and c_h are the lower and upper edge of the allocated BW,

Δf is the SCS, and

$Y(t,f)$ is the frequency domain signal evaluated for in-band emissions as defined in the subsection E.3.3

The allocated RB power per RB and the total allocated RB power are given by:

$$P_{RB} = \frac{1}{|T_s| \cdot L_{CRBs}} \sum_{t \in T_S} \sum_{c_1}^{c_1+(12 \cdot L_{CRBs}-1)\cdot\Delta f} |\mathrm{MS}(t,f)|^2 [\mathrm{dBm}/(12\Delta f)]$$

$$P_{All-RBs} = \frac{1}{|T_s|} \sum_{t \in T_S} \sum_{c_l}^{c_l+(12 \cdot L_{CRBs}-1)*\Delta f} |\mathrm{MS}(t,f)|^2 \ [\mathrm{dBm}]$$

The relative in-band emissions, applicable for General and IQ image, are given by:

$$Emissions_{relative}(\Delta_{RB}) = 10 \cdot \log_{10}\left(\frac{Emissions_{absolute}(\Delta_{RB})}{\frac{1}{|T_S| \cdot L_{CRBS}} \sum_{t \in T_S} \sum_{c_l}^{c_l+(12 \cdot L_{CRBS}-1)\cdot\Delta f} |\mathrm{MS}(t,f)|^2}\right)[\mathrm{dB}] =$$

$$= Emissions_{absolute}(\Delta_{RB})[\mathrm{dBm}/12\Delta f] - P_{RB}[dBm/12\Delta f]$$

where

L_{CRBs} is the number of allocated resource blocks,

and

$\mathrm{MS}(t, f)$ is the frequency domain samples for the allocated bandwidth, as defined in the subsection E.3.3.

The relative in-band emissions, applicable for carrier leakage, is given by:

$$Emissions_{relative} = 10 \cdot \log_{10}\left(\frac{Emissions_{absolute}(RBnextDC)}{\frac{1}{|T_S|} \sum_{t \in T_S} \sum_{c_l}^{c_l+(12 \cdot L_{CRBS}-1)\cdot\Delta f} |\mathrm{MS}(t,f)|^2}\right)[\mathrm{dBc}]$$
$$= Emissions_{absolute}(RBnextDC)[\mathrm{dBm}/12\Delta f] - P_{All\ RBs}[\mathrm{dBm}]$$

where RBnextDC means: Resource Block next to the carrier.

This can be one RB or one pair of RBs, depending whether the DC carrier is inside an RB or in-between two RBs.

Although an exclusion period may be applicable in the time domain, when evaluating EVM, the inband emissions measurement interval is defined over one complete slot in the time domain.

From the acquired samples *n* functions for general in band emissions and IQ image inband emissions can be derived. n values or n pairs of carrier leakage inband emissions can be derived. They are compared against different limits.

E.4.4 EVM equalizer spectrum flatness

For EVM equalizer spectrum flatness use EC(f) as defined in E.3.3. Note, EC(f) represents equalizer coefficient $f \in F$, f is the allocated subcarriers within the transmission bandwidth (($|F|$=12* L_{CRBs})

From the acquired samples n functions EC(f) can be derived.

EC(f) is broken down to 2 functions:

$$\mathrm{EC}_1(\mathrm{f}),\ f \in Range\ \ 1$$

$$EC_2(f),\ f \in Range\ \ 2$$

Where Range 1 and Range 2 are as defined in Table 6.5.2.4.5-1 for normal condition and Table 6.5.2.4.5-2 for extreme condition

The following peak to peak ripple is calculated:

$RP_1 = 20 * \log(\max(|EC_1(f)|)/\min(|EC_1(f)|))$,which denote the maximum ripple in Range 1

$RP_2 = 20 * \log(\max(|EC_2(f)|)/\min(|EC_2(f)|))$,which denote the maximum ripple in Range 2

$RP_{12} = 20 * \log(\max(|EC_1(f)|)/\min(|EC_2(f)|))$,which denote the maximum ripple between the upper side of Range 1 and lower side of Range 2

$RP_{21} = 20 * \log(\max(|EC_2(f)|)/\min(|EC_1(f)|))$,which denote the maximum ripple between the upper side of Range 2 and lower side of Range 1

E.4.5 Frequency error and Carrier leakage

See E.3.1.

E.4.6 EVM of Demodulation reference symbols (EVM_{DMRS})

For the purpose of EVM_{DMRS}, the steps E.2.2 to E.4.2 are repeated 6 times, constituting 6 EVM_{DMRS} sub-periods. The only purpose of the repetition is to cover the longer gross measurement period of EVM_{DMRS} ($6 \cdot n$ time slots) and to derive the FFT window timing per sub-period.

The bigger of the EVM results in one n TS period corresponding to the timing $\Delta\tilde{c}$ –W/2 or $\Delta\tilde{c}$ +W/2 is compared against the limit. (Clause E.4.2) This timing is re-used for EVM_{DMRS} in the equivalent EVM_{DMRS} sub-period.

For EVM the demodulation reference symbols are excluded, while the data symbols are used. For EVM_{DMRS} the data symbols are excluded, while the demodulation references symbols are used. This is illustrated in figure E.4.6-1

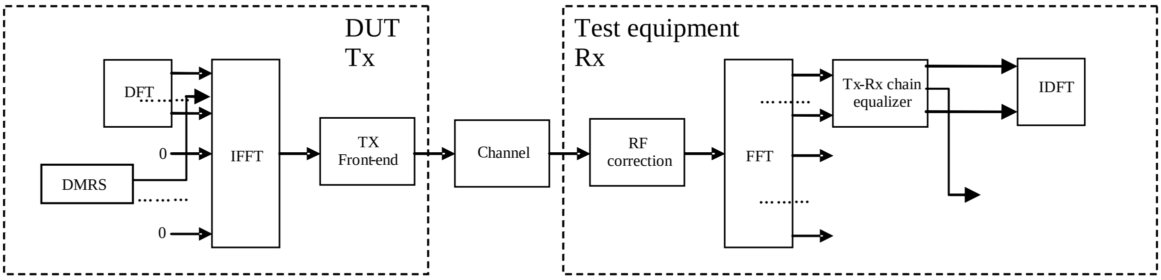

Figure E.4.6-1: EVM_{DMRS} measurement points

Re-use the following formula from E.3.3:

$$Z'(f,t) = MS(f,t) \cdot EC(f)$$

To calculate EVM_{DMRS} , the data symbol (t=0,1,3,4,5,6,8,9,10,12,13) in Z'(f,t) are excluded and only the reference symbols (t=2,7,11) is used.

The EVM_{DMRS} is the difference between the ideal waveform and the measured and equalized waveform for the allocated RB(s)

$$EVM_{DMRS} = \sqrt{\frac{\sum_{t\in T}\sum_{f\in F}\left|Z'(f,t)-I(f,t)\right|^2}{|T|\cdot P_0\cdot|F|}},$$

where

t covers the count of demodulation reference symbols (i.e. symbols 2,7,11 in each slot, so count=3)

f covers the count of demodulation reference symbols within the allocated bandwidth. (|F|=12* L_{CRBs} (with L_{CRBs} : number of allocated resource blocks)).

$Z'(f,t)$ are the samples of the signal evaluated for the EVM $_{DMRS}$

$I(f,t)$ is the ideal signal reconstructed by the measurement equipment, and

P_0 is the average power of the ideal signal. For normalized modulation symbols P_0 is equal to 1.

n such results are generated per measurement sub-period.

E.4.6.1 1st average for EVM $_{DMRS}$

EVM $_{DMRS}$ is averaged over all basic EVM $_{DMRS}$ measurements in one sub-period

The averaging comprises n UL slots

$$1stEVM_{DMRS} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(EVM_{DMRS,i}\right)^2}$$

The timing is taken from the EVM for the data. 6 of those results are achieved from the samples. In general the timing is not the same for each result.

E.4.6.2 Final average for EVM $_{DMRS}$

$$finalEVM_{DMRS} = \sqrt{\frac{1}{6}\sum_{i=1}^{6}\left(1stEVM_{DMRS,i}\right)^2}$$

E.5 EVM and inband emissions for PUCCH

For the purpose of worst case testing, the PUCCH shall be located on the edges of the Transmission Bandwidth Configuration (6,15,25,50,75,100 RBs).

The EVM for PUCCH (EVM_{PUCCH}) is averaged over *n* slots, where

$$n = \begin{cases} 30, \text{ for 60 kHz SCS} \\ 60, \text{ for 120 kHz SCS} \end{cases}.$$

At least *n* TSs shall be transmitted by the UE without power change. SRS multiplexing shall be avoided during this period. The following transition periods are applicable: One OFDM symbol on each side of the slot border (instant of band edge alternation).

The description below is generic in the sense that all 5 PUCCH formats are covered. Although the number of OFDM symbols in one slot can be different from 7 (depending on the format, configuration and cyclic prefix length), the text below uses 7 without excluding the others.

E.5.1 Basic principle

The basis principle is the same as described in E.2.1

E.5.2 Output signal of the TX under test

The output signal of the TX under test is processed same as described in E.2.2

E.5.3 Reference signal

The reference signal is defined same as in E.2.3. Same as in E.2.3, $i_1(\nu)$ is the ideal reference for EVM_{PUCCH} and $i_2(\nu)$ is used to estimate the FFT window timing.

Note PUSCH is off during the PUCCH measurement period.

E.5.4 Measurement results

The measurement results are:

- EVM_{PUCCH}
- Inband emissions with the sub-results: General in-band emission, IQ image (according to: 38.101. Annex F.4, Clause starting with: "At this stage the ….")

E.5.5 Measurement points

The measurement points are illustrated in the Figure E.2.5-1.

E.5.6 Pre FFT minimization process

The pre FFT minimisation process is the same as describes in clause E.3.1.

NOTE: although an exclusion period for EVM_{PUCCH} is applicable in E.5.9.1, the pre FFT minimisation process is done over the complete slot.

RF error, and carrier leakage are necessary for best fit of the measured signal towards the ideal signal in the pre FFT domain. However they are not used to compare them against the limits.

E.5.7 Timing of the FFT window

Timing of the FFT window is estimated with the same method as described in E.3.2.

E.5.8 Post FFT equalisation

The post FFT equalisation is described separately without reference to E.3.3:

Perform 14 FFTs on z'(ν), one for each OFDM symbol in a slot using the timing $\Delta\tilde{c}$, including the demodulation reference symbol. The result is an array of samples, 14 in the time axis t times 2048 in the frequency axis f. The samples represent the OFDM symbols (data and reference symbols) in the allocated RBs and inband emissions in the non allocated RBs within the transmission BW.

Only the allocated resource blocks in the frequency domain are used for equalisation.

The nominal reference symbols and **nominal** OFDM data symbols are used to equalize the measured data symbols.

Note: (The nomenclature inside this note is local and not valid outside)

The nominal OFDM data symbols are created by a demodulation process. A demodulation process as follows is recommended:

1. Equalize the measured OFDM data symbols using the reference symbols for equalisation. Result: Equalized OFDM data symbols

2. Decide for the nearest constellation point, however not independent for each subcarrier in the RB. 12 constellation points are decided dependent, using the applicable CAZAC sequence. Result: Nominal OFDM data symbols

At this stage we have an array of Measured data-Symbols and reference-Symbols (MS(f,t))

versus an array of Nominal data-Symbols and reference Symbols (NS(f,t))

The arrays comprise in sum 7 data and reference symbols, depending on the PUCCH format, in the time axis and the number of allocated sub-carriers in the frequency axis.

MS(f,t) and NS(f,t) are processed with a least square (LS) estimator, to derive one equalizer coefficient per time slot and per allocated subcarrier. EC(f)

$$EC(f) = \frac{\sum_{t=0}^{6} NS(f,t)^{*} NS(f,t)}{\sum_{t=0}^{6} MS(f,t)^{*} NS(f,t)}$$

With * denoting complex conjugation.

EC(f) are used to equalize the OFDM data together with the demodulation reference symbols by:

Z'(f,t) = MS(f,t) · EC(f)

With · denoting multiplication.

Z'(f,t) is used to calculate EVM_{PUCCH}, as described in E.5.9 1

NOTE: although an exclusion period for EVM_{PUCCH} is applicable in E.5.9.1, the post FFT minimisation process is done over 7 OFDM symbols.

The samples of the non allocated resource blocks within the transmission bandwidth configuration in the post FFT domain are called Y(f,t) (f covering the non allocated subcarriers within the transmission bandwidth configuration, t covering the OFDM symbols during 1 slot).

E.5.9 Derivation of the results

E.5.9.1 EVM_{PUCCH}

For EVM_{PUCCH} create two sets of Z'(f,t)., according to the timing " $\Delta\tilde{c}$ –W/2 and $\Delta\tilde{c}$ +W/2" using the equalizer coefficients from E.5.8

The EVM_{PUCCH} is the difference between the ideal waveform and the measured and equalized waveform for the allocated RB(s)

$$EVM_{PUCCH} = \sqrt{\frac{\sum_{t \in T} \sum_{f \in F} \left| Z'(f,t) - I(f,t) \right|^2}{|T| \cdot P_0 \cdot |F|}},$$

where

the OFDM symbols next to slot boarders (instant of band edge alternation) are excluded:

t covers less than the count of demodulated symbols in the slot (|T|= 5)

f covers the count of subcarriers within the allocated bandwidth. (|F|=12)

$Z'(f,t)$ are the samples of the signal evaluated for the EVM_{PUCCH}

$I(f,t)$ is the ideal signal reconstructed by the measurement equipment, and

P_0 is the average power of the ideal signal. For normalized modulation symbols P_0 is equal to 1.

From the acquired samples 2*n* EVM_{PUCCH} value can be derived, *n* values for the timing $\Delta\tilde{c}$ –W/2 and *n* values for the timing $\Delta\tilde{c}$ +W/2

E.5.9.2 Averaged EVM_{PUCCH}

EVM_{PUCCH} is averaged over all basic EVM_{PUCCH} measurements

The averaging comprises *n* UL slots

$$\overline{EVM}_{PUCCH} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(EVM_{PUCCH,i}\right)^2}$$

The averaging is done separately for timing $\Delta\tilde{c}$ –W/2 and $\Delta\tilde{c}$ +W/2 leading to $\overline{EVM}_{PUCCH,low}$ and $\overline{EVM}_{PUCCH,high}$

$EVM_{PUCCH,final} = \max(\overline{EVM}_{PUCCH,low}, \overline{EVM}_{PUCCH,high})$ is compared against the test requirements.

E.5.9.3 In-band emissions measurement

The in-band emissions are a measure of the interference falling into the non-allocated resources blocks

Create one set of Y(t,f) per slot according to the timing "$\Delta\tilde{c}$"

For the non-allocated RBs the in-band emissions are calculated as follows

$$Emissions_{absolute}(\Delta_{RB}) = \begin{cases} \frac{1}{|T_s|}\sum_{t\in T_s}\sum_{\max(f_{\min},(c_l+12\cdot\Delta_{RB}*\Delta f))}^{c_l+(12\cdot\Delta_{RB}+11)*\Delta f} |Y(t,f)|^2, \Delta_{RB} < 0 \\ \frac{1}{|T_s|}\sum_{t\in T_s}\sum_{c_h+(12\cdot\Delta_{RB}-11)*\Delta f}^{\min(f_{\max},(c_h+12\cdot\Delta_{RB}*\Delta f))} |Y(t,f)|^2, \Delta_{RB} > 0 \end{cases},$$

where

the upper formula represents the inband emissions below the allocated frequency block and the lower one the inband emissions above the allocated frequency block.

T_s is a set of $|T_s|$ OFDM symbols in the measurement period,

Δ_{RB} is the starting frequency offset between the allocated RB and the measured non-allocated RB (e.g. $\Delta_{RB} = 1$ for the first upper or $\Delta_{RB} = -1$ for the first lower adjacent RB),

$f_{\min}$ and $f_{\max}$ are the lower and upper edge of the UL system BW,

c_l and c_h are the lower and upper edge of the allocated BW,

Δf is the SCS, and

$Y(t, f)$ is the frequency domain signal evaluated for in-band emissions as defined in the subsection E.5.8

The relative in-band emissions are, given by

$$Emissions_{relative}(\Delta_{RB}) = 10 * \log_{10} \frac{Emissions_{absolute}(\Delta_{RB})}{\frac{1}{|T_s| \cdot L_{CRBs}} \sum_{t \in T_s} \sum_{c_1}^{c_1 + (12 \cdot L_{CRBs} - 1) * \Delta f} |\mathrm{MS}(t, f)|^2} [dB]$$

where

L_{CRBs} is the number of allocated RBs,

and $\mathrm{MS}(t, f)$ is the frequency domain samples for the allocated bandwidth, as defined in the subsection E.5.8

Although an exclusion period for EVM is applicable in E.5.9.1, the inband emissions measurement interval is defined over one complete slot in the time domain.

From the acquired samples *n* functions for inband emissions can be derived.

Since the PUCCH allocation is always on the upper or lower band-edge, the opposite of the allocated one represents the IQ image, and the remaining inner RBs represent the general inband emissions. They are compared against different limits.

E.6 EVM for PRACH

The description below is generic in the sense that all PRACH formats are covered. The numbers, used in the text below are taken from PRACH format B4 without excluding the other formats. The sampling rate for the PUSCH, 122.88 Mbps in the time domain, is re-used for the PRACH. The carrier spacing of the PUSCH is up to 48 times higher than that of PRACH depending on the PRACH format and SCS. This results in an oversampling factor *ovf* of up to 48, when acquiring the time samples for the PRACH. The pre-FFT algorithms (clauses E.6.6 and E.6.7) use all time samples, although oversampled. For the FFT the time samples are decimated by the *ovf*, resulting in the same FFT size as for the other transmit modulation tests. Decimation requires a decision, which samples are used and which ones are rejected. The algorithm in E.6.6, Timing of the FFT window, can also be used to decide about the used samples.

E.6.1 Basic principle

The basis principle is the same as described in E.2.1

E.6.2 Output signal of the TX under test

The output signal of the TX under test is processed same as described in E.2.2

The measurement period is TBD.

E.6.3 Reference signal

The test description in 6.4.2.1.4.1 is based on non-contention based access:

- PRACH configuration index (responsible for Preamble format, System frame number and subframe number)
- Preamble ID
- Preamble power

signalled to the UE, defines the reference signal unambiguously, such that no demodulation process is necessary to gain the reference signal.

The reference signal i(v) is constructed by the measuring equipment according to the relevant TX specifications, using the following parameters: the applicable Zadoff Chu sequence, nominal carrier frequency, nominal amplitude and phase for each subcarrier, nominal timing, no carrier leakage. It is represented as a sequence of samples at a sampling rate of 122.88 Mbps in the time domain.

E.6.4 Measurement results

The measurement result is:

- EVMPRACH

E.6.5 Measurement points

The measurement points are illustrated in the figure below:

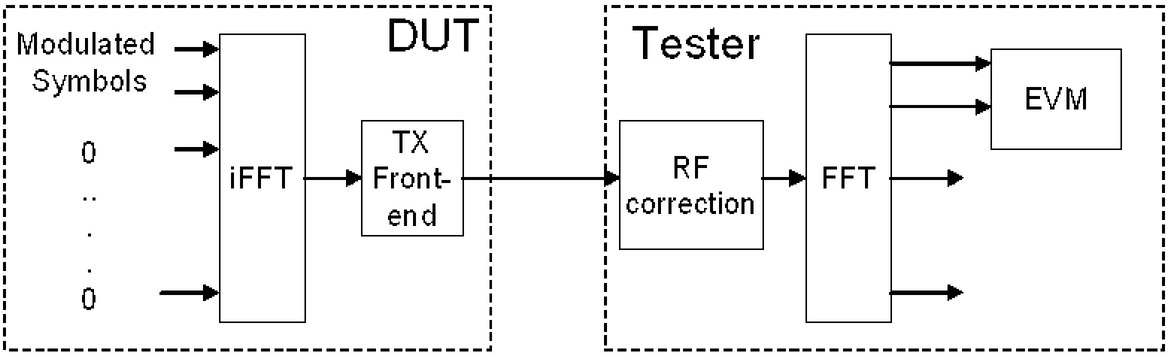

Figure E.6.5-1

E.6.6 Pre FFT minimization process

The pre-FFT minimization process is applied to each PRACH preamble separately. The time period for the pre- FFT minimisation process includes the complete CP and Zadoff-Chu sequence (in other words, the power transition period is per definition outside of this time period) Sample timing, Carrier frequency and carrier leakage in z(ν) are jointly varied in order to minimise the difference between z(ν) and i(ν). Best fit (minimum difference) is achieved when the RMS difference value between z(ν) and i(ν) is an absolute minimum.

After this process the samples z(ν) are called $z^0(\nu)$.

RF error, and carrier leakage are necessary for best fit of the measured signal towards the ideal signal in the pre FFT domain. However they are not used to compare them against the limits.

E.6.7 Timing of the FFT window

The FFT window length is $24576 \cdot 2^{-\mu}$samples for preamble format B4, however in the measurement period at least $27744 \cdot 2^{-\mu}$samples are taken where $\mu \in \{2,3\}$. The position in time for FFT must be determined.

In an ideal signal, the FFT may start at any instant within the cyclic prefix without causing an error. The TX filter, however, reduces the window. The EVM requirements shall be met within a window W<CP.

The reference instant for the FFT start is the centre of the reduced window, called $\Delta\tilde{c}$,

EVM is measured at the following two instants: $\Delta\tilde{c}$ –W/2 and $\Delta\tilde{c}$ +W/2.

The timing of the measured signal $z^0(\nu)$ with respect to the ideal signal i(ν) is determined in the pre FFT domain as follows:

Correlation between $z^0(\nu)$ and i(ν) will result in a correlation peak. The meaning of the correlation peak is approx. the "impulse response" of the TX filter. The correlation peak, (the highest, or in case of more than one, the earliest) indicates the timing in the measured signal with respect to the ideal signal.

W is different for different preamble formats and shown in Table E.6.7-1 for $L_{\mathrm{RA}} = 139$ and $\Delta f^{\mathrm{RA}} = 15 \cdot 2^{\mu}$ kHz where $\mu \in \{2,3\}$.

Table E.6.7-1 EVM window length for PRACH formats for $L_{\mathrm{RA}} = 139$

Preamble format	Cyclic prefix length N_{cp}	Nominal FFT size[1]	EVM window length *W* in FFT samples	Ratio of *W* to CP*
A1	$288 \cdot 2^{-\mu}$	$4096 \cdot 2^{-\mu}$	$144 \cdot 2^{-\mu}$	50.0%
A2	$576 \cdot 2^{-\mu}$	$8192 \cdot 2^{-\mu}$	$432 \cdot 2^{-\mu}$	75.0%
A3	$864 \cdot 2^{-\mu}$	$12288 \cdot 2^{-\mu}$	$720 \cdot 2^{-\mu}$	83.3%
B1	$216 \cdot 2^{-\mu}$	$4096 \cdot 2^{-\mu}$	$72 \cdot 2^{-\mu}$	33.3%
B2	$360 \cdot 2^{-\mu}$	$8192 \cdot 2^{-\mu}$	$216 \cdot 2^{-\mu}$	60.0%
B3	$504 \cdot 2^{-\mu}$	$12288 \cdot 2^{-\mu}$	$360 \cdot 2^{-\mu}$	71.4%
B4	$936 \cdot 2^{-\mu}$	$24576 \cdot 2^{-\mu}$	$792 \cdot 2^{-\mu}$	84.6%
C0	$1240 \cdot 2^{-\mu}$	$2048 \cdot 2^{-\mu}$	$1096 \cdot 2^{-\mu}$	88.4%
C2	$2048 \cdot 2^{-\mu}$	$8192 \cdot 2^{-\mu}$	$1904 \cdot 2^{-\mu}$	93.0%
Note 1: The use of other FFT sizes is possible as long as appropriate scaling of the window length is applied. Note 2: These percentages are informative.				

The number of samples, used for FFT is reduced compared to $z^0(v)$. This subset of samples is called z''(v).

The sample frequency [122.88 MHz] is oversampled with respect to the PRACH-subcarrier spacing of $\Delta f^{\mathrm{RA}} = 15 \cdot 2^{\mu}$ kHz. EVM is based on [2048] samples per PRACH preamble and requires decimation of the time samples by the factor of $12 \cdot 2^{\mu}$. The final number of samples per PRACH preamble, used for FFT is reduced compared to z''(v) by the same factor. This subset of samples is called z'(v).

E.6.8 Post FFT equalisation

Equalisation is not applicable for the PRACH.

E.6.9 Derivation of the results

E.6.9.1 EVM$_{\mathrm{PRACH}}$

Perform FFT on z'(v) and i(v) using the FFT timing $\Delta\tilde{c}$ –W/2 and $\Delta\tilde{c}$ +W/2.

[For format TBD the first and the repeated preamble sequence are FFT-converted separately. using the standard FFT length of [2048].]

The EVM$_{\mathrm{PRACH}}$ is the difference between the ideal waveform and the measured and equalized waveform for the allocated RB(s).

$$EVM_{PRACH} = \sqrt{\frac{\sum_{f \in F} \left| Z'(f) - I(f) \right|^2}{N_{ZC} \cdot P_0}},$$

where

f covers the count of demodulated symbols within the allocated bandwidth.

$Z'(f)$ are the samples of the signal evaluated for the EVM$_{\mathrm{PRACH}}$

$I(f)$ is the ideal signal reconstructed by the measurement equipment, and

P_0 is the average power of the ideal signal. For normalized modulation symbols P_0 is equal to 1.

N_{ZC} is random access preamble sequence length.

From the acquired samples TBD EVM_{PRACH} values can be derived, TBD values for the timing $\Delta\tilde{c}$ –W/2 and TBD values for the timing $\Delta\tilde{c}$ +W/2.

E.6.9.2 Averaged EVM_{PRACH}

The PRACH EVM, EVM_{PRACH}, is averaged over TBD preamble sequence measurements.

$$\overline{EVM}_{\mathrm{PRACH}} = \sqrt{\frac{1}{m}\sum_{i=1}^{m}\left(EVM_{\mathrm{PRACH},i}\right)^2}$$

where m is TBD.

The averaging is done separately for timing $\Delta\tilde{c}$ –W/2 and $\Delta\tilde{c}$ +W/2 leading to $\overline{EVM}_{PRACH,low}$ and $\overline{EVM}_{PRACH,high}$

$EVM_{PRACH,final} = \max(\overline{EVM}_{PRACH,low}, \overline{EVM}_{PRACH,high})$ is compared against the test requirements.

Annex F (normative): Measurement uncertainties and Test Tolerances

F.1 Acceptable uncertainty of Test System (normative)

TBD

F.1.1 Measurement of test environments

TBD

F.1.2 Measurement of transmitter

Editor's note:

- The measurement uncertainties for 6.5.2.1 Spectrum Emission Mask and 6.5.2.3 Adjacent Channel Leakage Ratio are based on a preliminary MU assessment and require an approval of the uncertainty contributors to be included in the uncertainty assessment as well as the contributors need further technical analysis.

Table F.1.2-1: Maximum Test System Uncertainty for transmitter tests

Sub clause	Maximum Test System Uncertainty	Test setup	Derivation of Test System Uncertainty
6.2.1.1 UE maximum output power (EIRP and TRP)	TBD	DFF	
	PC3 Minimum peak EIRP, Max EIRP DUT ≤ 15 cm [±4.41] dB (FR2a) [±4.78] dB (FR2b) DUT ≤ 30 cm [±4.30] dB (FR2a) [±4.67] dB (FR2b) Max TRP DUT ≤ 15 cm [±4.32] dB (FR2a) [±4.69] dB (FR2b) DUT ≤ 30 cm [±4.22] dB (FR2a) [±4.59] dB (FR2b)	IFF	
	TBD	NFTF	
6.2.1.2 UE maximum output power (Spherical coverage)	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
6.2.2 UE maximum output power for modulation / channel bandwidth	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
6.2.3 UE maximum output power with additional requirements	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
6.2.4 Configured transmitted power	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
6.3.1 Minimum output power	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
6.3.2 Transmit OFF power	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
6.3.3.2 General ON/OFF time mask	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
6.3.3.3 Transmit power time mask for slot boundaries	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
6.3.3.4 PRACH time mask	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
6.3.3.5 PUCCH time mask	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
6.3.3.5.1 Long PUCCH time mask	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
6.3.3.5.2 Short PUCCH time mask	TBD	DFF	

	TBD	IFF	
	TBD	NFTF	
6.3.3.6 SRS time mask	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
6.3.3.7 PUSCH-PUCCH and PUSCH-SRS time masks	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
6.4.1 Frequency error	± 0.01 ppm	DFF	
	± 0.01 ppm	IFF	
	± 0.01 ppm	NFTF	
6.4.2.1 Error vector magnitude	TBD	DFF	
	TBD	IFF	
6.4.2.2 Carrier leakage	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
6.4.2.3 In-band emissions	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
6.4.2.4 EVM equalizer spectrum flatness	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
6.4.2.5 EVM equalizer spectrum flatness for BPSK modulation	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
6.5.1 Occupied bandwidth	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
6.5.2.1 Spectrum Emission Mask	TBD	DFF	
	DUT ≤ 15 cm TBD DUT ≤ 30 cm [±4.57] dB, 23.45GHz ≤ f ≤ 30.3GHz [±5.57] dB, 30.3GHz < f ≤ 40.8GHz	IFF	
	TBD	NFTF	
6.5.2.2 Additional Spectrum Emissions Mask	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
6.5.2.3 Adjacent Channel Leakage Ratio	TBD	DFF	
	DUT ≤ 15 cm TBD DUT ≤ 30 cm BW = 50MHz [±4.57] dB, 23.45GHz ≤ f ≤ 30.3GHz [±4.93] dB, 30.3GHz < f ≤ 40.8GHz	IFF	
	TBD	NFTF	
6.5.3.1 Transmitter Spurious emissions	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
6.5.3.2 Spurious emission band UE co-existence	TBD	DFF	
	TBD	IFF	
	TBD	NFTF	
NOTE 1: FR2a: 23.45GHz ≤ f < 32.125GHz FR2b: 32.125GHz ≤ f ≤ 40.8GHz			

F.1.3 Measurement of receiver

Table F.1.3-1: Maximum Test System Uncertainty for receiver tests

Sub clause	Maximum Test System Uncertainty	Test setup	Derivation of Test System Uncertainty
7.3.2 Reference sensitivity power level	TBD	DFF	
	[±5.02] dB (DUT ≤ 15 cm, FR2a, FR2b) [±4.93] dB (DUT ≤ 30 cm, FR2a, FR2b)	IFF	
7.4 Maximum input level	TBD	DFF	
	TBD	IFF	
7.5 Adjacent channel selectivity	TBD	DFF	
	TBD	IFF	
7.6.2 In-band blocking	TBD	DFF	
	TBD	IFF	
7.6.3 Out-of-band blocking	TBD	DFF	
	TBD	IFF	
7.7 Spurious response	TBD	DFF	
	TBD	IFF	
7.9 Spurious emissions	TBD	DFF	
	TBD	IFF	
NOTE 1: FR2a and FR2b are specified in Table F.1.2-1.			

F.2 Interpretation of measurement results (normative)

TBD

F.3 Test Tolerance and Derivation of Test Requirements (informative)

TBD

F.3.1 Measurement of test environments

TBD

F.3.2 Measurement of transmitter

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

- The TT values defined in this section are valid only until RAN5#85 (November 2019).
- RAN5 expects to have the following actions performed by RAN5#85 in efforts to improve the TT values
    1. For updated TT evaluation only, MU analysis taking into the account the data sheet from commercially available test systems or any additional experimental data to justify the values
    2. UE vendors' have supplied further input on TT based on the performance of the existing mmWave UE against the RF test cases.
    3. At least one statistical analysis has been done on possibilities to improve test confidence level.
    4. Measurement results & evaluation of network performance / commercially available devices has been provided.

Table F.3.2-1: Derivation of Test Requirements (Transmitter tests)

Sub clause	Test Tolerance (TT)	Formula for test requirement
6.2.1.1 UE maximum output power (EIRP and TRP)	PC1 Minimum peak EIRP TBD Max TRP TBD Max EIRP 0 dB PC2 Minimum peak EIRP TBD Max TRP TBD Max EIRP 0 dB PC3 Minimum peak EIRP IFF (DUT ≤ 15 cm) [2.9] dB (FR2a) [3.1] dB (FR2b) IFF (DUT ≤ 30 cm) [2.8] dB (FR2a) [3.0] dB (FR2b) Max TRP IFF (DUT ≤ 15 cm) [2.8] dB (FR2a) [3.0] dB (FR2b) IFF (DUT ≤ 30 cm) [2.7] dB (FR2a) [3.0] dB (FR2b) Max EIRP 0 dB PC4 Minimum peak EIRP TBD Max TRP TBD Max EIRP 0 dB	
6.2.1.2 UE maximum output power (Spherical coverage)	PC1 TBD PC2 TBD PC3 TBD PC4 TBD	
6.2.2 UE maximum output power for modulation / channel bandwidth	TBD	

6.2.3 UE maximum output power with additional requirements	TBD	
6.2.4 Configured transmitted power	TBD	
6.3.1 Minimum output power	TBD	
6.3.2 Transmit OFF power	0 dB	
6.3.3.2 General ON/OFF time mask	TBD	
6.3.3.3 Transmit power time mask for slot boundaries	TBD	
6.3.3.4 PRACH time mask	TBD	
6.3.3.5 PUCCH time mask	TBD	
6.3.3.5.1 Long PUCCH time mask	TBD	
6.3.3.5.2 Short PUCCH time mask	TBD	
6.3.3.7 PUSCH-PUCCH and PUSCH-SRS time masks	TBD	
6.4.1 Frequency error	[0.005] ppm	
6.4.2.1 Error vector magnitude	0%, up to 64QAM	Minimum requirement + TT
6.4.2.2 Carrier leakage	TBD	
6.4.2.3 In-band emissions	TBD	
6.4.2.4 EVM equalizer spectrum flatness	TBD	
6.4.2.5 EVM equalizer spectrum flatness for BPSK modulation	TBD	
6.5.1 Occupied bandwidth	0 kHz	Minimum requirement + TT
6.5.2.1 Spectrum Emission Mask	IFF (DUT ≤ 15 cm) TBD IFF (DUT ≤ 30 cm) [4.6] dB (23.45GHz ≤ f ≤ 30.3GHz) [5.6] dB (30.3GHz ≤(1) f ≤ 40.8GHz)	Editor's note: ≤(1) will become <
6.5.2.2 Additional Spectrum Emissions Mask	TBD	
6.5.2.3 Adjacent Channel Leakage Ratio	Absolute requirement 0 dB Relative requirement IFF (DUT ≤ 15 cm) TBD IFF (DUT ≤ 30 cm) BW = 50MHz [4.6] dB (23.45GHz ≤ f ≤ 30.3GHz) [5.0] dB (30.3GHz ≤(1) f ≤ 40.8GHz)	Editor's note: ≤(1) will become <
6.5.3.1 Transmitter Spurious emissions	0 dB	Minimum requirement + TT
6.5.3.2 Spurious emission band UE co-existence	0 dB	Minimum requirement + TT
NOTE 1: FR2a: 23.45GHz ≤ f < 32.125GHz FR2b: 32.125GHz ≤ f ≤ 40.8GHz		

F.3.3 Measurement of receiver

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

- The TT values defined in this section are valid only until RAN5#85 (November 2019).
- RAN5 expects to have the following actions performed by RAN5#85 in efforts to improve the TT values

    5. For updated TT evaluation only, MU analysis taking into the account the data sheet from commercially available test systems or any additional experimental data to justify the values

6. UE vendors' have supplied further input on TT based on the performance of the existing mmWave UE against the RF test cases.

7. At least one statistical analysis has been done on possibilities to improve test confidence level.

8. Measurement results & evaluation of network performance / commercially available devices has been provided.

Table F.3.3-1: Derivation of Test Requirements (Receiver tests)

Sub clause	Test Tolerance (TT)	Formula for test requirement
7.3.2 Reference sensitivity power level	IFF (DUT ≤ 15 cm, FR2a, FR2b) [3.3] dB IFF (DUT ≤ 30 cm, FR2a, FR2b) [3.2] dB	
7.4 Maximum input level	TBD	
7.5 Adjacent channel selectivity	0 dB	Wanted signal power + TT T-put limit unchanged
7.6.2 In-band blocking	0 dB	Wanted signal power + TT T-put limit unchanged
7.6.3 Out-of-band blocking	0 dB	Wanted signal power + TT T-put limit unchanged
7.7 Spurious response	0 dB	Wanted signal power + TT T-put limit unchanged
7.9 Spurious emissions	0 dB	Minimum requirement + TT T-put limit unchanged
NOTE 1: FR2a and FR2b are specified in Table F.3.2-1.		

Annex G (normative): Uplink Physical Channels

G.0 Uplink Signal Levels

Please refer to Annex G.0 in TS 38.521-1 [13].

G.1 General

Please refer to Annex G.1 in TS 38.521-1 [13].

G.2 Set-up

Please refer to Annex G.2 in TS 38.521-1 [13].

G.3 Connection

Please refer to Annex G.3 in TS 38.521-1 [13].

G.3.0 Measurement of Transmitter Characteristics

Please refer to Annex G.3.0 in TS 38.521-1 [13].

G.3.1 Measurement of Receiver Characteristics

Please refer to Annex G.3.1 in TS 38.521-1 [13].

Annex H (normative): Statistical Testing

Editor's Note:

- Further investigate the technical details behind this statistical method to ensure that this is applicable for FR2 radiated test cases.

H.1 General

FFS.

H.2 Statistical testing of receiver characteristics

H.2.1 General

The test of receiver characteristics is two fold.

1. A signal or a combination of signals is offered to the RX port(s) of the receiver.

2. The ability of the receiver to demodulate /decode this signal is verified by measuring the throughput.

In (2) is the statistical aspect of the test and is treated here.

The minimum requirement for all receiver tests is >95% of the maximum throughput.

All receiver tests are performed in static propagation conditions. No fading conditions are applied.

H.2.2 Mapping throughput to error ratio

a) The measured information bit throughput R is defined as the sum (in kilobits) of the information bit payloads successfully received during the test interval, divided by the duration of the test interval (in seconds).

b) In measurement practice the UE indicates successfully received information bit payload by signalling an ACK to the SS.
If payload is received, but damaged and cannot be decoded, the UE signals a NACK.

c) Only the ACK and NACK signals, not the data bits received, are accessible to the SS.
The number of bits is known in the SS from knowledge of what payload was sent.

d) For the reference measurement channel, applied for testing, the number of bits is different in different subframes, however in a radio frame it is fixed during one test.

e) The time in the measurement interval is composed of successfully received subframes (ACK), unsuccessfully received subframes (NACK) and no reception at all (DTX-subframes).

f) DTX-subframes may occur regularly according the applicable reference measurement channel (regDTX).
In real live networks this is the time when other UEs are served. In TDD these are the UL and special subframes.
regDTX vary from test to test but are fixed within the test.

g) Additional DTX-subframes occur statistically when the UE is not responding ACK or NACK where it should. (statDTX)
This may happen when the UE was not expecting data or decided that the data were not intended for it.

The pass / fail decision is done by observing the:

- number of NACKs
- number of ACKs and
- number of statDTXs (regDTX is implicitly known to the SS)

The ratio `(NACK + statDTX)/(NACK+ statDTX + ACK)`is the Error Ratio (ER). Taking into account the time consumed by the ACK, NACK, and DTX-TTIs (regular and statistical), ER can be mapped unambiguously to throughput for any single reference measurement channel test.

H.2.3 Design of the test

The test is defined by the following design principles (see clause H.x, Theory….):

1. The early decision concept is applied.
2. A second limit is introduced: Bad DUT factor M>1
3. To decide the test pass:

   Supplier risk is applied based on the Bad DUT quality

   To decide the test fail

   Customer Risk is applied based on the specified DUT quality

The test is defined by the following parameters:

1. Limit ER = 0.05 (Throughput limit = 95%)
2. Bad DUT factor M=1.5 (selectivity)
3. Confidence level CL = 95% (for specified DUT and Bad DUT-quality)

H.2.4 Numerical definition of the pass fail limits

Table H.2.4-1: pass fail limits

ne	ns_p	ns_f	ne	ns_p	ns_f	ne	ns_p	ns_f	ne	ns_p	ns_f
0	67	NA	39	763	500	78	1366	1148	117	1951	1828
1	95	NA	40	778	516	79	1381	1166	118	1965	1845
2	119	NA	41	794	532	80	1396	1183	119	1980	1863
3	141	NA	42	810	548	81	1412	1200	120	1995	1881
4	162	NA	43	826	564	82	1427	1217	121	2010	1899
5	183	NA	44	842	580	83	1442	1234	122	2025	1916
6	202	NA	45	858	596	84	1457	1252	123	2039	1934
7	222	NA	46	873	612	85	1472	1269	124	2054	1952
8	241	NA	47	889	629	86	1487	1286	125	2069	1969
9	259	NA	48	905	645	87	1502	1303	126	2084	1987
10	278	76	49	920	661	88	1517	1321	127	2099	2005
11	296	88	50	936	678	89	1532	1338	128	2113	2023
12	314	100	51	952	694	90	1547	1355	129	2128	2040
13	332	113	52	967	711	91	1562	1373	130	2143	2058
14	349	126	53	983	727	92	1577	1390	131	2158	2076
15	367	140	54	998	744	93	1592	1407	132	2172	2094
16	384	153	55	1014	760	94	1607	1425	133	2187	2111
17	401	167	56	1029	777	95	1623	1442	134	2202	2129
18	418	181	57	1045	793	96	1637	1459	135	2217	2147
19	435	195	58	1060	810	97	1652	1477	136	2231	2165
20	452	209	59	1076	827	98	1667	1494	137	2246	2183
21	469	224	60	1091	844	99	1682	1512	138	2261	2201
22	486	238	61	1106	860	100	1697	1529	139	2275	2218
23	503	253	62	1122	877	101	1712	1547	140	2290	2236
24	519	268	63	1137	894	102	1727	1564	141	2305	2254
25	536	283	64	1153	911	103	1742	1582	142	2320	2272
26	552	298	65	1168	928	104	1757	1599	143	2334	2290
27	569	313	66	1183	944	105	1772	1617	144	2349	2308
28	585	328	67	1199	961	106	1787	1634	145	2364	2326
29	602	343	68	1214	978	107	1802	1652	146	2378	2344
30	618	359	69	1229	995	108	1817	1669	147	2393	2361
31	634	374	70	1244	1012	109	1832	1687	148	2408	2379
32	650	389	71	1260	1029	110	1847	1704	149	2422	2397
33	667	405	72	1275	1046	111	1861	1722	150	2437	2415
34	683	421	73	1290	1063	112	1876	1740	151	2452	2433
35	699	436	74	1305	1080	113	1891	1757	152	2466	2451
36	715	452	75	1321	1097	114	1906	1775	153*)	NA	2469
37	731	468	76	1336	1114	115	1921	1793			
38	747	484	77	1351	1131	116	1936	1810	*) note 2 in H.2.5		

NOTE 1: The first column is the number of errors (ne = number of NACK + statDTX)

NOTE 2: The second column is the number of samples for the pass limit (ns_p, ns=Number of Samples= number of `NACK + statDTX + ACK`)

NOTE 3: The third column is the number of samples for the fail limit (ns_f)

H.2.5 Pass fail decision rules

The pass fail decision rules apply for a single test, comprising one component in the test vector. The over all Pass /Fail conditions are defined in clause H.2.6and H.2A.6

Having observed 0 errors, pass the test at 67+ samples, otherwise continue

Having observed 1 error, pass the test at 95+ otherwise continue

Having observed 2 errors, pass the test at 119+ samples, fail the test at 2- samples, otherwise continue

Etc. etc.

Having observed 151 errors, pass the test at 2452+ samples, fail the test at 2433- samples, otherwise continue

Having observed 152 errors, pass the test at 2466+ samples, fail the test at 2451- samples.

Where x+ means: x or more, x- means x or less

NOTE 1: an ideal DUT passes after 67 samples. The maximum test time is 2466 samples.

NOTE 2: It is allowed to deviate from the early decision concept by postponing the decision (pass/fail or continue). Postponing the decision to or beyond the end of Table H.2.4-1 requires a pass fail decision against the test limit: pass the DUT for ER<0.0618, otherwise fail.

Annex I (normative): Requirement for the TRP measurement grid for spurious emissions

TRP measurement grid selection for spurious emissions is up to test system implementation but shall meet the criteria shown in Table I-3.

Table I-1: Single Antenna Element Radiation Pattern for spurious emission measurements

Antenna element horizontal radiation pattern	$A_{E,H}(\varphi) = -\min\left[12\left(\frac{\varphi}{\varphi_{3dB}}\right)^2, A_m\right] dB$, A_m =30 dB
Antenna element vertical radiation pattern	$A_{E,V}(\theta) = -\min\left[12\left(\frac{\theta - 90}{\theta_{3dB}}\right)^2, SLA_v\right]$, SLA_v =30 dB
Array element radiation pattern	$A_E(\varphi,\theta) = G_{E,\max} - \min\left\{-\left[A_{E,H}(\varphi) + A_{E,V}(\theta)\right], A_m\right\}$
Element gain without antenna losses	$G_{E,max}$ = 1.5 dBi

Table I-2: Composite Antenna Array Radiation Pattern for spurious emission measurements

Composite array radiation pattern in dB $A_A(\theta,\varphi)$	$A_{A,Beami}(\theta,\varphi) = A_E(\theta,\varphi) + 10\log_{10}\left(\left\|\sum_{m=1}^{N_H}\sum_{n=1}^{N_V} w_{i,n,m} \cdot v_{n,m}\right\|^2\right)$ the super position vector is given by: $v_{n,m} = \exp\left(i \cdot 2\pi\left((n-1)\cdot\frac{d_V}{\lambda}\cdot\cos(\theta) + (m-1)\cdot\frac{d_H}{\lambda}\cdot\sin(\theta)\cdot\sin(\varphi)\right)\right),$ $n = 1,2,\ldots N_V; m = 1,2,\ldots N_H;$ the weighting is given by: $w_{i,n,m} = \frac{1}{\sqrt{N_H N_V}}\exp\left(i \cdot 2\pi\left((n-1)\cdot\frac{d_V}{\lambda}\cdot\sin(\theta_{i,etilt}) - (m-1)\cdot\frac{d_H}{\lambda}\cdot\cos(\theta_{i,etilt})\cdot\sin(\varphi_{i,escan})\right)\right)$
Horizontal radiating element spacing dh/λ	0.5
Vertical radiating element spacing dv/λ	0.5

Table I-3: TRP measurement grid requirement for spurious emission measurements

Test Case	Measurement Grid Selection Criteria	Parameters for antenna array radiation pattern assumption in Table I-1 and Table I-2		Random orientation for derivation of standard deviation and MU
		Antenna array configuration (Row×Column)	half-power beamwidth of single element	
Transmitter spurious (fine TRP measurement for 2nd harmonic frequency range)	TRP standard deviation ≤ 0.25dB	8 x 2	$\varphi_{3dB} = 260°$ $\theta_{3dB} = 130°$	≥ 10,000
Transmitter spurious (fine TRP measurement for non-2nd harmonic frequency range)	TRP standard deviation ≤ 0.25dB AND Number of points ≥ 14	1 x 1	$\varphi_{3dB} = \theta_{3dB} = 90°$	≥ Ceil(2,000,000/Number of points)
Transmitter spurious (coarse TRP measurement for 2nd harmonic frequency range)	Number of points ≥ 26	8 x 2	$\varphi_{3dB} = 260°$ $\theta_{3dB} = 130°$	≥ Ceil(2,000,000/Number of points)
Transmitter spurious (coarse TRP measurement for non-2nd harmonic frequency range)	Number of points ≥ 14	1 x 1	$\varphi_{3dB} = \theta_{3dB} = 90°$	≥ Ceil(2,000,000/Number of points)

Annex J (normative): Test applicability per permitted test method

This annex describes, per test requirement, the permitted test methodologies as a function of DUT antenna configuration.

Table J-1: Test case applicability per permitted test method

Clause	No DUT antenna configuration declaration	DUT antenna configuration declaration		
		Configuration 1 (one antenna panel with D ≤ 5 cm active at any one time)	**Configuration 2** (More than one antenna panel D ≤ 5 cm without phase coherency between panels active at any one time)	**Configuration 3** (Any phase coherent antenna panel of any size)
6.5.1 Occupied bandwidth	IFF	DFF, DFF simplification, IFF, NFTF	DFF, DFF simplification, IFF, NFTF	IFF
6.5.2.1 Spectrum Emission Mask	IFF	DFF, DFF simplification, IFF, NFTF	DFF, DFF simplification, IFF, NFTF	IFF
6.5.2.3 Adjacent leakage ratio	IFF	DFF, DFF simplification, IFF, NFTF	DFF, DFF simplification, IFF, NFTF	IFF
7.5 Adjacent Channel Selectivity	IFF	DFF, DFF simplification, IFF, NFTF	DFF, DFF simplification, IFF, NFTF	IFF
7.6.2 In-band Blocking	IFF	DFF, DFF simplification, IFF, NFTF	DFF, DFF simplification, IFF, NFTF	IFF
NOTE: D = DUT radiating aperture declared by UE vendor.				

Annex K (normative): EIRP and EIS measurement procedures

Annex K defines the EIRP and EIS measurement procedures along with Tx and Rx beam peak direction search and corresponding spherical coverage procedures for the permitted testing methodologies defined in [5].

K.1 Direct far field (DFF)

K.1.1 TX beam peak direction search and EIRP spherical coverage

This Tx beam peak search procedure applies to DUTs with and without beam correspondence. The TX beam peak direction is found with a 3D EIRP scan (separately for each orthogonal downlink polarization). The TX beam peak direction search grid points for this single grid approach are defined in Annex G.2 of TR38.810. Alternatively, a coarse and fine grid approach could be used according to the definition in Annex G.2.4 of TR38.810.

For each measurement point of the TX beam peak direction search grid, perform the following procedure:

1) Connect the SS (System Simulator) with the DUT through the measurement antenna with $Pol_{Link}=\theta$ polarization to form the TX beam towards the measurement antenna.
2) Calculate total EIRP as per K.1.3 using $Pol_{Link}=\theta$.
3) Unlock the beam.
4) Connect the SS (System Simulator) with the DUT through the measurement antenna with $Pol_{Link}=\phi$ polarization to form the TX beam towards the measurement antenna.
5) Calculate total EIRP as per K.1.3 using $Pol_{Link}=\phi$.

The TX beam peak direction is where the maximum total component of EIRP($Pol_{Link}=\theta$) or EIRP($Pol_{Link}=\phi$) is found.

The EIRP results from the TX beam peak search using the minimum number of grid points as described in Annex G.2 of TR38.810 can be re-used for EIRP spherical coverage. In case a coarse beam peak grid is used for TX beam peak search, using the minimum number of grid points defined in Annex G.3.3.2.3 of TR38.810, the EIRP results can be re-used for EIRP spherical coverage.

In case a separate test is performed for EIRP spherical coverage, the procedure above should be followed using the minimum number of grid points defined in Annex G.3.3.2.3 of TR38.810 for spherical coverage.

The $EIRP_{target\text{-}CDF}$ is then obtained from the Cumulative Distribution Function (CDF) computed using total EIRP for all grid points. When using constant step size measurement grids, a theta-dependent correction shall be applied, i.e., the PDF probability contribution for each measurement point is scaled by sin(θ).

K.1.2 RX beam peak direction search and EIS spherical coverage

The RX beam peak direction is found with a 3D EIS scan (separately for each orthogonal downlink polarization). The RX beam peak direction search grid points for this single grid approach are defined in Annex G.2 of TR38.810. Alternatively, a coarse and fine grid approach could be used according to the definition in Annex G.2.4 of TR38.810.

For each measurement point of the RX beam peak direction search grid, perform the following procedure:

1) Establish a connection between the DUT and the SS with the downlink signal applied to the $Pol_{Link}=\theta$-polarization of the measurement antenna.
2) Position the UE so that the beam is formed towards the measurement antenna in the desired RX beam direction.
3) Calculate averaged EIS as per K.1.4

The RX beam peak direction is where the minimum EIS is found.

The EIS results from the RX beam peak search using the minimum number of grid points as described in Annex G.2 of TR38.810 can be re-used for EIS spherical coverage. In case a coarse beam peak grid is used for RX beam peak search with an EIS metric, using the minimum number of grid points defined in Annex G.3.3.2.3 of TR38.810, the EIS results can be re-used for EIS spherical coverage. In case a separate test is performed for spherical coverage, the procedure above should be followed using the minimum number of grid points defined in Annex G.3.3.2.3 of TR38.810 for spherical coverage.

The $EIS_{target-CDF}$ is then obtained from the Cumulative Distribution Function (CDF) computed using total EIS for all grid points. When using constant step size measurement grids, a theta-dependent correction shall be applied, i.e., the PDF probability contribution for each measurement point is scaled by sin(θ).

K.1.3 EIRP measurement procedure

This section describes EIRP measurement procedure.

The TX beam peak direction is found with a 3D EIRP scan (separately for each orthogonal polarization) with a grid that is TBD. The TX beam peak direction is where the maximum total component of EIRP is found.

1) Measure the mean power P_{meas} (Pol_{Meas}=θ, Pol_{Link}) of the modulated signal arriving at the power measurement equipment (such as a spectrum analyser, power meter, or gNB emulator).

2) Calculate EIRP(Pol_{Meas}=θ, Pol_{Link}) by adding the composite loss of the entire transmission path for utilized signal path, $L_{EIRP,\theta}$, and frequency to the measured power P_{meas} (Pol_{Meas}=θ, Pol_{Link}).

3) Measure the mean power P_{meas} (Pol_{Meas}=ϕ, Pol_{Link}) of the modulated signal arriving at the power measurement equipment.

4) Calculate EIRP(Pol_{Meas}=ϕ, Pol_{Link}) by adding the composite losses of the entire transmission path for utilized signal path, $L_{EIRP,\varphi}$ and frequency to the measured power P_{meas} (Pol_{Meas}=ϕ, Pol_{Link})

5) Calculate total EIRP (Pol_{Link}) = EIRP(Pol_{Meas}=θ, Pol_{Link}) + EIRP(Pol_{Meas}=ϕ, Pol_{Link})

K.1.4 EIS measurement procedure

This section describes EIS measurement procedure.

1) Determine EIS(Pol_{Meas}=θ, Pol_{Link}=θ) for θ-polarization, i.e., the power level for the θ-polarization at which the throughput exceeds the requirements for the specified reference measurement channel

2) Switch the downlink to the Pol_{Link}=φ-polarization of the measurement antenna

3) Determine EIS(Pol_{Meas}=ϕ, Pol_{Link}=ϕ) for φ-polarization, i.e., the power level for the φ-polarization at which the throughput exceeds the requirements for the specified reference measurement channel

4) Calculate the resulting averaged EIS as:

$$EIS = 2*[1/EIS(Pol_{Meas}=\theta, Pol_{Link}=\theta) + 1/EIS(Pol_{Meas}=\phi, Pol_{Link}=\phi)]^{-1}$$

K.2 Direct far field (DFF) simplification

K.2.1 3D EIRP scan procedure for TX beam peak search

Same measurement procedure as in clause K.1.1.

K.2.2 3D EIS scan procedure for RX beam peak search

Same measurement procedure as in clause K.1.2.

K.2.3 EIRP measurement procedure

Same measurement procedure as in clause K.1.3.

K.2.4 EIS measurement procedure

Same measurement procedure as in clause K.1.4.

K.3 Indirect far field (IFF)

K.3.1 3D EIRP scan procedure for TX beam peak search

Same measurement procedure as in clause K.1.1.

K.3.2 3D EIS scan procedure for RX beam peak search

Same measurement procedure as in clause K.1.2.

K.3.3 EIRP measurement procedure

Same measurement procedure as in clause K.1.3.

K.3.4 EIS measurement procedure

Same measurement procedure as in clause K.1.4.

K.4 Near field to far field transform (NFTF)

K.4.1 3D EIRP scan procedure for TX beam peak search

The TX beam peak direction is found with a 3D EIRP scan (separately for each orthogonal polarization) with a grid that is TBD. The TX beam peak direction is where the maximum total component of EIRP is found.

FFS

K.4.2 EIRP measurement procedure

1) Connect the SS (System Simulator) to the DUT through the measurement antenna with polarization reference Pol_{Meas} to form the TX beam towards the previously determined TX beam peak direction and respective polarization.

2) Lock the beam toward that direction for the entire duration of the test.

3) Perform a 3D pattern measurement (amplitude and phase) with the DUT sending a modulated signal.

4) Determine the EIRP for both polarization towards the TX beam peak direction by using a Near Field to Far Field transform.

5) Calculate total EIRP = $EIRP_{\theta}$ + $EIRP_{\phi}$

Annex L (normative): TRP measurement procedure

Annex L defines the TRP measurement procedure for the permitted testing methodologies defined in [5].

L.1 Direct far field (DFF)

1) Connect the SS with the DUT through the downlink antenna with desired polarization reference Pol_{Meas} to form the TX beam towards the desired TX beam direction and respective polarization.

2) Lock the beam toward that direction and polarization for the entire duration of the test.

3) For each measurement point on the TBD grid, measure $P_{meas,\theta}$ and $P_{meas,\varphi}$. The angle between the measurement antenna and the DUT (θ_{Meas}, φ_{Meas}) is achieved by rotating the measurement antenna and the DUT (based on system architecture).

4) Calculate $EIRP_\theta$ ($EIRP_\varphi$) by adding the composite loss of the entire transmission path for utilized signal paths, $L_{EIRP,\theta}$ ($L_{EIRP,\varphi}$) and frequency to the measured powers $P_{meas,\theta}$ ($P_{meas,\varphi}$)

5) The TRP value for the uniform measurement grid is calculated using

$$TRP = \frac{\pi}{2NM}\sum_{i=1}^{N-1}\sum_{j=0}^{M-1}\left[EIRP_\theta(\theta_i,\phi_j) + EIRP_\phi(\theta_i,\phi_j)\right]\sin(\theta_i)$$

Where N is the number of angular intervals in the nominal theta range from 0 to π and M is the number of angular intervals in the nominal phi range from 0 to 2π.

The TRP values for the constant density grids are calculated using:

$$TRP = \frac{1}{N}\sum_{i=0}^{N-1}\left[EIRP_\theta(\theta_i,\phi_i) + EIRP_\phi(\theta_i,\phi_i)\right]$$

where N is the number of measurement points.

L.2 Direct far field (DFF) simplification

Same measurement procedure as in clause L.1.

L.3 Indirect far field (IFF)

Same measurement procedure as in clause L.1.

L.4 Near field to far field transform (NFTF)

1) Connect the SS to the DUT through the measurement antenna with polarization reference Pol_{Meas} to form the TX beam towards the previously determined TX beam peak direction and respective polarization.

2) Lock the beam toward that direction for the entire duration of the test.

3) Perform a 3D pattern measurement (amplitude and phase) with the DUT sending a modulated signal.

4) For each measurement point on the TBD grid, determine the EIRP for both polarization by using a Near Field to Far Field transform.

3) The TRP value for the constant step size measurement grids are calculated using

$$TRP = \frac{\pi}{2NM}\sum_{i=1}^{N-1}\sum_{j=0}^{M-1}\left[EIRP_\theta(\theta_i,\phi_j) + EIRP_\phi(\theta_i,\phi_j)\right]\sin(\theta_i)$$

Where N is the number of angular intervals in the nominal theta range from 0 to π and M is the number of angular intervals in the nominal phi range from 0 to 2 π. The TRP values for the constant density grids are calculated using:

$$TRP = \frac{1}{N}\sum_{i=0}^{N-1}\left[EIRP_{\theta}(\theta_i,\phi_i) + EIRP_{\phi}(\theta_i,\phi_i)\right]$$

where N is the number of measurement points.

Annex M:(normative)
Measurement grids

This appendix describes the assumptions and definition of the minimum number of measurement grid points for various grid types. Further details can be found in [5].

A total of three measurement grids are considered:

- Beam Peak Search Grid: using this grid, the TX and RX beam peak direction will be determined. 3D EIRP scans are used to determine the TX beam peak direction and 3D Throughput/RSRP/EIS scans for RX beam peak directions.

- Spherical Coverage Grid: using this grid, the CDF of the EIRP/EIS distribution in 3D is calculated to determine the spherical coverage performance.

- TRP Measurement Grid: using this grid, the total power radiated by the DUT in the TX beam peak direction is determined by integrating the EIRP measurements taken on the sampling grid.

M.1 Grid Types

Two different measurement grid types are considered:

- The constant step size grid type has the azimuth and elevation angles uniformly distributed as in the examples illustrated in Figures M.1-1 in 2D and M.1-2 in 3D.

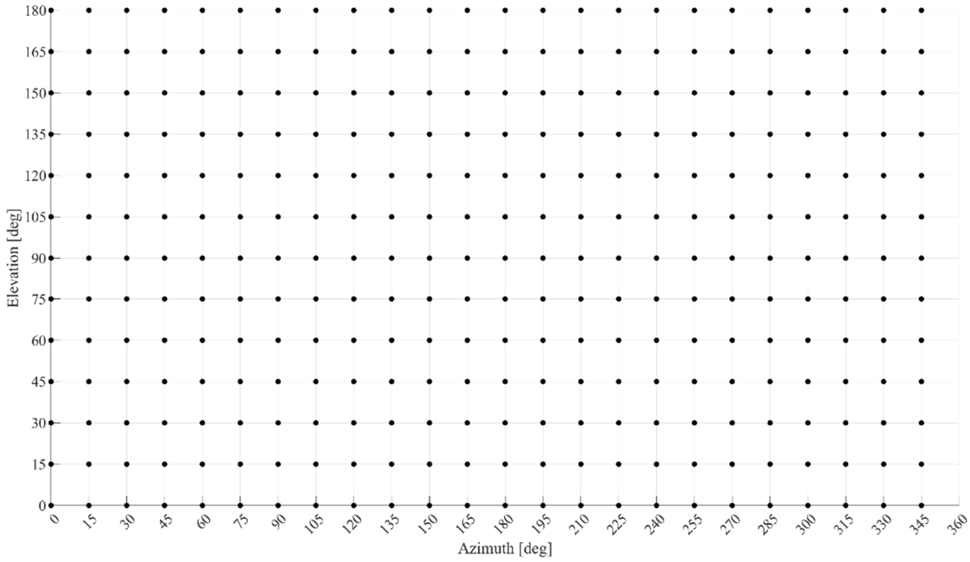

Figure M.1-1: Distribution of measurement grid points in 2D for a constant step size grid with Δθ=Δϕ=15º (266 unique measurement points)

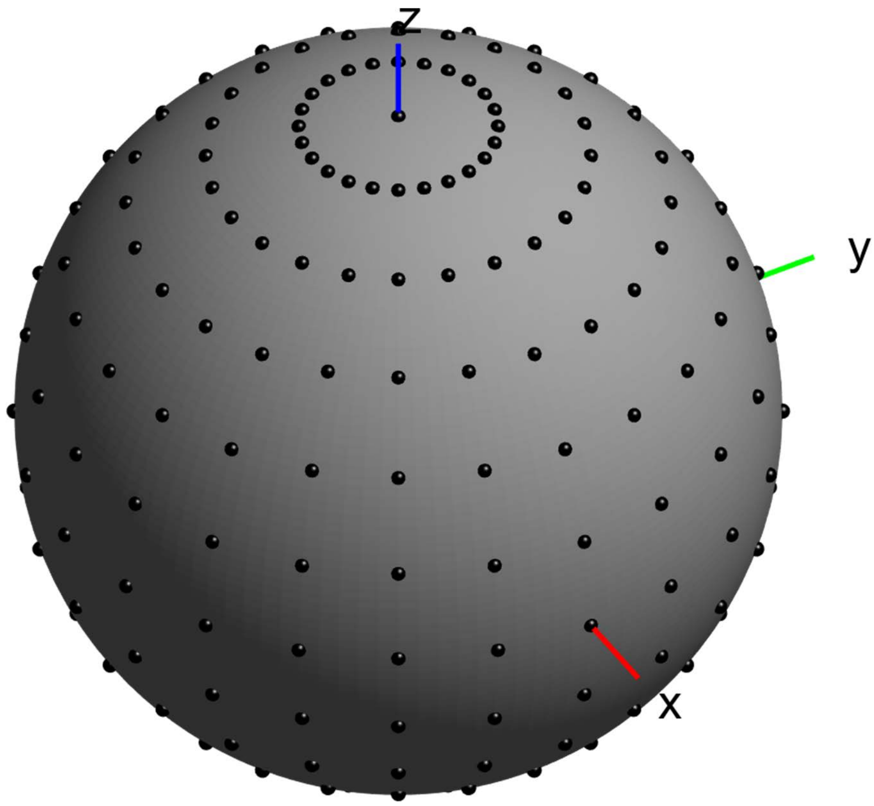

Figure M.1-2: Distribution of measurement grid points in 3D for a constant step size grid with Δθ=Δϕ=15º (266 unique measurement points)

- Constant density grid types have measurement points that are evenly distributed on the surface of the sphere with a constant density as in the example illustrated in Figures M.1-3 in 2D and M.1-4 in 3D.

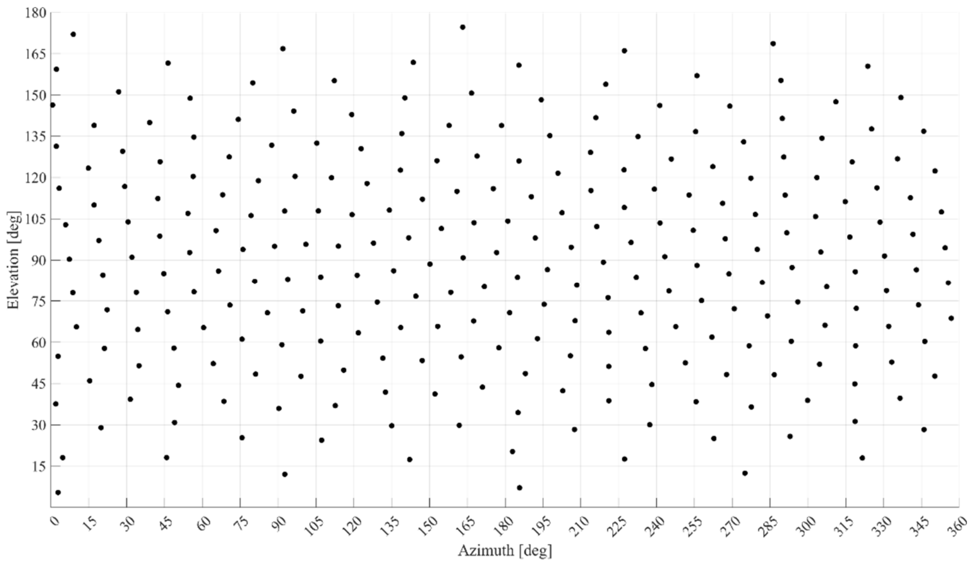

Figure M.1-3: Distribution of measurement grid points in 2D for a constant density grid with 266 unique measurement points

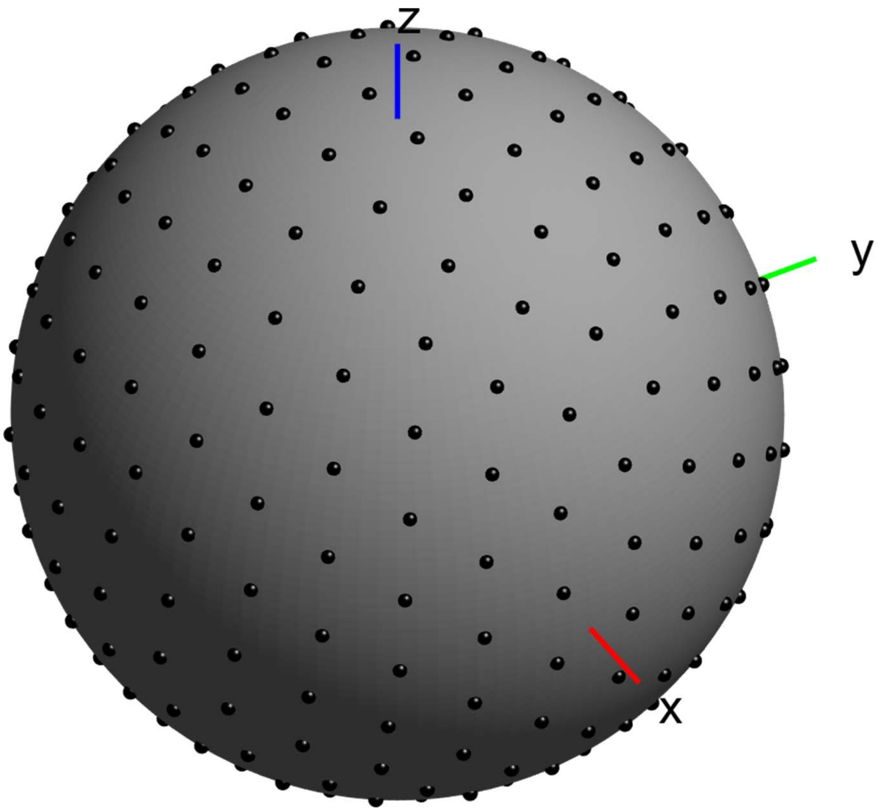

Figure M.1-4: Distribution of measurement grid points in 3D for a constant density grid type with 266 unique measurement points

M.2 Beam Peak Search Grid

Editor's note:

- Other implementations are not precluded as far as the respective analysis are presented and included in this TS

M.2.1 Power class 3 devices

In order to make a reasonable trade-off between measurement uncertainties, at least 800(constant density grid with charged particle implementation) or 1106 (constant step size grid) measurement grid points shall be used for beam peak search procedures. For better measurement uncertainties, finer measurement grids as shown below may be used. Choice of grids among these 2 types of grids is up to test system implementation.

Table M.2.1-1: Minimum number of unique grid points for sample systematic errors (non-sparse antenna arrays)

Systematic Error of 'Beam Peak Search': Offset from Beam Peak at which CDF is 5%	Minimum Number of Unique Grid Points for Constant Step Size Grid	Minimum Number of Unique Grid Points for Constant Density Grid (charged particle implementation)
0.2dB	2522 (5º step size)	2000
0.3dB	1742 (6º step size)	1500
0.4dB	N/A	1000
0.5dB	1106 (7.5ºstep size)	800

M.3 Spherical Coverage Grid

- Editor's note: Other implementations are not precluded as far as the respective analysis are presented and included in this TS

M.3.1 EIRP spherical coverage

M.3.1.1 Power class 3 devices

In order to make a reasonable trade-off between measurement uncertainties, at least 200 (constant density grid with charged particle implementation) or 266 (constant step size grid) measurement grid points shall be used for EIRP spherical coverage procedure. For better measurement uncertainties, finer measurement grids as shown below may be used. Choice of grids among these 2 types of grids is up to test system implementation.

There is no need to have the Tx beam peak placed on a measurement grid point.

For constant step size measurement grids, the CDF analyses require the PDFs to be scaled by sin(theta).

Table M.3.1.1-1: Statistical results of EIRP50%CDF for the 8x2 antenna array for constant density measurement grids (with charged particle implementation) and the beam peak oriented in completely random orientations errors (non-sparse antenna arrays)

Number of unique grid points	STD [dB]	|Mean Error| [dB]
200	0.11	0.02
300	0.08	0.01
400	0.07	0.01
500	0.06	0.01

Table M.3.1.1-2: Statistical results of EIRP50%CDF for the 8x2 antenna array for constant step size measurement grids and the beam peak oriented in completely random orientations errors (non-sparse antenna arrays)

Step Size [º]	Number of unique grid points	STD [dB]	|Mean Error| [dB]
9	762	0.05	0.00
10	614	0.06	0.00
12	422	0.07	0.01
15	266	0.12	0.01

M.3.2 EIS spherical coverage

M.3.2.1 Power class 3 devices

In order to make a reasonable trade-off between measurement uncertainties, at least 200 (constant density grid with charged particle implementation) or 266 (constant step size grid) measurement grid points shall be used for EIS spherical coverage procedure. For better measurement uncertainties, finer measurement grids as shown below may be used. Choice of grid(s) among these 2 types of grids is up to test system implementation.

There is no need to have the Rx beam peak placed on a measurement grid point.

For constant step size measurement grids, the CCDF analyses require the PDFs to be scaled by sin(theta).

Table M.3.2.1-1: Statistical results of EIS50%CDF for the 8x2 antenna array for constant step size measurement grids and the beam peak oriented in completely random orientations errors (non-sparse antenna arrays)

	DL Power Step Size: infinitesimal	DL Power Step Size: 0.1dB	DL Power Step Size: 0.5dB	DL Power Step Size: 1dB

Step Size [º]	Number of unique grid points	STD [dB]	|Mean Error| [dB]	STD [dB]	|Mean Error| [dB]	STD [dB]	|Mean Error| [dB]	STD [dB]	|Mean Error| [dB]
6.0	1742	0.03	0.00	0.03	0.10	0.03	0.50	0.02	1.02
9.0	762	0.05	0.00	0.05	0.10	0.05	0.50	0.04	1.02
10.0	614	0.06	0.00	0.06	0.10	0.06	0.50	0.05	1.02
12.0	422	0.08	0.01	0.07	0.10	0.07	0.50	0.07	1.02
15.0	266	0.12	0.02	0.12	0.10	0.11	0.50	0.10	1.02

Table M.3.2.1-2: Statistical results of EIS50%CDF for the 8x2 antenna array for constant density measurement grids (with charged particle implementation) and the beam peak oriented in completely random orientations errors (non-sparse antenna arrays)

	DL Power Step Size: infinitesimal		DL Power Step Size: 0.1dB		DL Power Step Size: 0.5dB		DL Power Step Size: 1dB	
Number of unique grid points	STD [dB]	|Mean Error| [dB]	STD [dB]	|Mean Error| [dB]	STD [dB]	|Mean Error| [dB]	STD [dB]	|Mean Error| [dB]
200	0.10	0.02	0.10	0.10	0.10	0.50	0.09	1.01
300	0.08	0.01	0.08	0.10	0.08	0.50	0.07	1.01
400	0.06	0.01	0.06	0.10	0.06	0.50	0.05	1.01
500	0.06	0.01	0.06	0.10	0.06	0.50	0.05	1.01

M.4 TRP Measurement Grid

Editor's note:

- Other implementations are not precluded as far as the respective analysis are presented and included in this TS

M.4.1 Power class 3 devices

In order to make a reasonable trade-off between measurement uncertainties, at least the following number of points should be included in the measurement grid for TRP measurements for non-sparse antenna arrays case:

- 135 measurement grid points for constant density grid – Charged Particle implementation, with standard deviation of 0.23 dB

- 12 latitudes and 19 longitudes for constant step size grid – sin (theta) weights integration approach, with standard deviation of 0.25dB.

12 latitudes and 19 longitudes for constant step size grid – Cleanshaw Curtis weights integration approach, with standard deviation of 0.20 dB

Choice of grid(s) among above 3 types of grids is up to test system implementation.

Annex N (informative): Change history

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2017-08	RAN5 #76	R5-174709	-	-	-	Draft skeleton	0.0.1
2018-01	RAN5#1-5G-NR Adhoc	R5-180002	-	-	-	Add references	0.1.0
2018-01	RAN5#1-5G-NR Adhoc	R5-180103	-	-	-	Add definitions, symbols and abbreviations	0.1.0
2018-01	RAN5#1-5G-NR Adhoc	R5-180104	-	-	-	Introduction of Operating bands and Channel arrangement	0.1.0
2018-01	RAN5#1-5G-NR Adhoc	R5-180094	-	-	-	Introduction of new test case 6.3.2 Transmit OFF power	0.1.0
2018-01	RAN5#1-5G-NR Adhoc	R5-180095	-	-	-	TP to add skeleton of 6.5.1 Occupied bandwidth to 38.521-2	0.1.0
2018-01	RAN5#1-5G-NR Adhoc	R5-180096	-	-	-	TP to add skeleton of 6.5.2.1 SEM to 38.521-2	0.1.0
2018-01	RAN5#1-5G-NR Adhoc	R5-180097	-	-	-	TP to add skeleton of 6.5.2.3 ACLR to 38.521-2	0.1.0
2018-03	RAN5 #78	R5-181508	-	-	-	Updated 38.521-2 to extend Annex with additional testing information	0.2.0
2018-03	RAN5 #78	R5-181680	-	-	-	TP to skeleton of 7.6.1 Inband blocking to 38.521-2	0.2.0
2018-03	RAN5 #78	R5-181681	-	-	-	5G-NR: Text Proposal to add spurious emissions test case to 38.521-2	0.2.0
2018-04	RAN5#2-5G-NR Adhoc	R5-181978	-	-	-	Update TS 38.521-2 further to align with the latest TS 38.101-2 spec structure.	0.3.1
2018-04	RAN5#2-5G-NR Adhoc	R5-182027	-	-	-	5G-NR Text Proposal to update spurious emissions test case to 38.521-2	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-182041	-	-	-	5G-NR Text Proposal to add REFSENS test case to 38.521-2	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-182009	-	-	-	General section updated to 38.521-2	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-182048	-	-	-	Addition of FR2 test case 6.3.1 Minimum Output Power	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-182049	-	-	-	Addition of FR2 test case 6.3.3.2 General ON/OFF time mask	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-181839	-	-	-	Definitions and abbreviations updated to 38.521-2	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-181840	-	-	-	Operating bands and Channel arrangement updated to 38.521-2	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-182008	-	-	-	Introduction of new test case 7.4 Maximum input level	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-182010	-	-	-	Common uplink configuration table for Tx test cases for TS 38.521-2 non-CA	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-182011	-	-	-	TP for 6.5.1 Occupied Bandwidth in TS 38.521-2	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-182029	-	-	-	TP for 6.5.2.1 Spectrum Emission Mask in TS 38.521-2	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-182031	-	-	-	TP for 6.5.2.3 Adjacent Channel Leakage Ratio in TS 38.521-2	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-182043	-	-	-	TP for 7.6.2 InBand Blocking in TS 38.521-2	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-182046	-	-	-	TP for 7.5 Adjacent channel selectivity in TS 38.521-2	0.4.0

2018-04	RAN5#2-5G-NR Adhoc	R5-181844	-	-	-	Add Annex G (normative): Measurement uncertainties and Test Tolerances	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-181844	-	-	-	Add clause 4.4 Test point analysis	0.4.0
2018-05	RAN5 #79	R5-183908	-	-	-	Introduction of New FR2 test case 6.3.3.4 PRACH time mask	0.5.0
2018-05	RAN5 #79	R5-182769	-	-	-	General section updated to 38.521-2	0.5.0
2018-05	RAN5 #79	R5-183914	-	-	-	TP for FR2 spurious test procedure (38.521-2)	0.5.0
2018-05	RAN5 #79	R5-183925	-	-	-	Update of Refsens test procedure for FR2	0.5.0
2018-05	RAN5 #79	R5-182883	-	-	-	Definitions, symbols and abbreviations updated to 38.521-2	0.5.0
2018-05	RAN5 #79	R5-182884	-	-	-	Operating bands and Channel arrangement updated to 38.521-2	0.5.0
2018-05	RAN5 #79	R5-182890	-	-	-	Update minimum conformance requirements and test requirement for 6.3.2 Transmit OFF power	0.5.0
2018-05	RAN5 #79	R5-183926	-	-	-	Annex for test case applicability per permitted test method	0.5.0
2018-05	RAN5 #79	R5-183712	-	-	-	Corrections annexes for EIRP and TRP metric definition	0.5.0
2018-05	RAN5 #79	R5-183927	-	-	-	Clean up TBD from Occupied Bandwidth, SEM and ACLR test cases	0.5.0
2018-05	RAN5 #79	R5-183928	-	-	-	Clean up TBD from ACS and Inband Blocking test cases	0.5.0
2018-05	RAN5 #79	R5-183948	-	-	-	Statistical Testing Annex for 38.521-2	0.5.0
2018-08	RAN5 #80	R5-185348	-	-	-	Correction to FR2 Spurious TC and introduction of TRP measurement grid requirement	1.0.0
2018-08	RAN5 #80	R5-185350	-	-	-	Addition of Frequency Error test case to TS 38.521-2	1.0.0
2018-08	RAN5 #80	R5-185490	-	-	-	FR2_TxSpurious_TestConfig_38.521-2	1.0.0
2018-08	RAN5 #80	R5-185562	-	-	-	FR2_StoreTxRxBeamPeakCoordinates_38.521-2	1.0.0
2018-08	RAN5 #80	R5-184742	-	-	-	Update of FR2 test case 6.3.1	1.0.0
2018-08	RAN5 #80	R5-184743	-	-	-	Update of FR2 test case 6.3.3.2	1.0.0
2018-08	RAN5 #80	R5-184856	-	-	-	General sections updated to 38.521-2	1.0.0
2018-08	RAN5 #80	R5-185519	-	-	-	Updates of FR2 TRx MU and TT in Annex	1.0.0
2018-08	RAN5 #80	R5-185555	-	-	-	FR2_UE_BeamlockInvoke_38.521-2	1.0.0
2018-08	RAN5 #80	R5-185191	-	-	-	Update to Occupied Bandwidth, SEM and ACLR test cases in TS 38.521-2	1.0.0
2018-08	RAN5 #80	R5-185192	-	-	-	Update to ACS and inband blocking test cases in TS 38.521-2	1.0.0
2018-08	RAN5 #80	R5-185187	-	-	-	FR2_RefSens_TestConfig_38.521-2	1.0.0
2018-08	RAN5 #80	R5-185188	-	-	-	DL and UL RMC updated for FR2 tests	1.0.0
2018-08	RAN5 #80	R5-185189	-	-	-	Downlink physical channel updated for FR2 tests	1.0.0
2018-08	RAN5 #80	R5-185190	-	-	-	OCNG Patterns updated for FR2 tests	1.0.0
2018-08	RAN5 #80	R5-185194	-	-	-	Update to Test frequencies for SEM in TS 38.521-2	1.0.0
2018-08	RAN5 #80	R5-185196	-	-	-	Addition of Carrier Leakage test case to TS 38.521-2	1.0.0
2018-08	RAN5 #80	R5-185193	-	-	-	Addition of Annex Global In-Channel TX-Test to 38.521-2	1.0.0
2018-08	RAN5 #80	R5-185197	-	-	-	Introduction of maximum output power test cases	1.0.0
2018-08	RAN5 #80	R5-185195	-	-	-	Addition of EVM test case to TS 38.521-2	1.0.0
2018-09	RAN #81	-	-	-	-	raised to v15.0.0 with editorial changes only	15.0.0
2018-12	RAN #82	R5-186504	0021	-	F	FR2 RefSens test case updates	15.1.0
2018-12	RAN #82	R5-186505	0022	-	F	Update Text on Store Beam Peak Coordinate	15.1.0
2018-12	RAN #82	R5-186510	0023	-	F	Structure updates to Annex C and G	15.1.0
2018-12	RAN #82	R5-186675	0026	-	F	Updating test case 6.2.3 maximum output power with additional requirements	15.1.0
2018-12	RAN #82	R5-187151	0034	-	F	Updated to Annexes for FR2 tests	15.1.0
2018-12	RAN #82	R5-187152	0035	-	F	General Information updated for TS38.521-2	15.1.0
2018-12	RAN #82	R5-187561	0042	-	F	Update to Table 5.3.5-1 in TS 38.521-2	15.1.0
2018-12	RAN #82	R5-187619	0050	-	F	Update of Section 6.3.3.1 General	15.1.0
2018-12	RAN #82	R5-187838	0045	1	F	Update of transmit signal quality test cases in 38.521-2	15.1.0
2018-12	RAN #82	R5-187839	0046	1	F	Addition of In-band Emissions test case to TS 38.521-2	15.1.0
2018-12	RAN #82	R5-187840	0047	1	F	Addition of EVM equalizer spectral flatness test cases 6.4.2.4 and 6.4.2.5 to TS 38.521-2	15.1.0
2018-12	RAN #82	R5-187841	0048	1	F	Update of Common Uplink Configuration for FR2	15.1.0
2018-12	RAN #82	R5-187842	0029	1	F	General sections updated to 38.521-2	15.1.0
2018-12	RAN #82	R5-187843	0044	1	F	Update of Global In-channel Tx Test Annex in 38.521-2	15.1.0
2018-12	RAN #82	R5-187886	0020	1	F	FR2 Spurious Emission test case updates	15.1.0

2018-12	RAN #82	R5-187912	0038	1	F	Addition of notes to clarify test point selection into general section of TS 38.521-2	15.1.0
2018-12	RAN #82	R5-188037	0032	1	F	Removing the Editor's notes of SA messages and procedures for all FR2 test cases	15.1.0
2018-12	RAN #82	R5-188038	0036	1	F	FR2 downlink signal level(38.521-2)	15.1.0
2018-12	RAN #82	R5-188063	0027	1	F	Update of FR2 6.3.2 Transmit OFF power	15.1.0
2018-12	RAN #82	R5-188212	0040	2	F	Updates to maximum output power test cases	15.1.0
2018-12	RAN #82	R5-188213	0028	1	F	Update of FR2 test case 7.4	15.1.0
2018-12	RAN #82	R5-188214	0025	1	F	Updates of TT in TS 38.521-2 Annex F during RAN5#81	15.1.0
2018-12	RAN #82	R5-188215	0031	1	F	TDD configuration for UE Tx test in FR2	15.1.0
2018-12	RAN #82	R5-188216	0039	1	F	Core alignment CR to capture TS 38.101-2 updates during RAN4#89	15.1.0
2018-12	RAN #82	R5-188217	0041	2	F	On measurement grids	15.1.0
2018-12	RAN #82	R5-188218	0043	1	F	Update to Annex K	15.1.0
2018-12	RAN #82	RP-182736	0024	2	F	Updates of MU Annex F	15.1.0

History

Document history		
V15.0.0	October 2018	Publication
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