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:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

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 radio transmission, radio reception and radio resource management test cases;

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

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*.

[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 radio transmission, radio reception and radio resource management test cases".

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

[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".

[26] 3GPP TS 38.306: "NR; User Equipment (UE) radio access capabilities".

[27] IEEE Std 149: "IEEE Standard Test Procedures for Antennas", IEEE.

[28] 3GPP TS 38.321: "NR; Medium Access Control (MAC) protocol specification".

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].

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

Beam correspondence: the ability of the UE to select a suitable beam for UL transmission based on DL measurements with or without relying on UL beam sweeping.

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.

Cumulative aggregated channel bandwidth: The cumulative aggregated channel bandwidth is defined as the frequency band from the lowest edge of the lowest CC to the upper edge of the highest CC of all UL and DL configured CCs.

EIRP(Link=TX beam peak direction, Meas=Link angle): 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. EIRP (indicator to be measured) can be replaced by Frequency, EVM, carrier Leakage, In-band emission and OBW.

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.

EIRP(Link=Spherical coverage grid, Meas=Link angle): measurement of the EIRP spherical coverage of the UE such that the EIRP link and measurement angles are aligned with the directions along the spherical coverage grid within an acceptable measurement error uncertainty. Alternatively, the spherical coverage grid can be replaced by the beam peak search grid as the results from the beam peak search can be re-used for spherical coverage.

EIS (effective isotropic sensitivity): sensitivity for an isotropic directivity device equivalent to the sensitivity of the discussed device exposed to an incoming wave from a defined AoA

NOTE 1: The sensitivity is the minimum received power level at which specific requirement is met.

NOTE 2: Isotropic directivity is equal in all directions (i.e. 0 dBi).

EIS(Link=RX beam peak direction, Meas=Link angle): measurement of the EIS of the UE such that the measurement angle is aligned with the RX 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.

IBM (Independent Beam Management): A UE that supports inter-band CA with IBM selects its DL Rx beam(s) for all CCs in each configured band based on DL reference signals measurements made in that band.

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 Annex N. If the beam lock function is used to lock the UE beam(s), the link angle can become any arbitrary AoA once the beam lock has been activated.

Measurement angle: the angle of measurement of the desired metric from the view point of the UE, as described in Annex N.

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

radiated requirements reference point: for the RF measurement setup, the radiated requirements reference point is located at the centre of the quiet zone. From the UE perspective the reference point is the input of the UE antenna array.

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.

TRP(Link=TX beam peak direction, Meas=TRP grid): measurement of the TRP of the UE such that the measurement angles are aligned with the directions of the TRP grid points within an acceptable measurement uncertainty while the link angle is aligned with the TX beam peak direction

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

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

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:

$\Delta EIRP_{BC}$	The beam correspondence tolerance, where $\Delta EIRP_{BC} = EIRP_2 - EIRP_1$
ΔF_{Global}	Granularity of the global frequency raster
ΔF_{Raster}	Band dependent channel raster granularity
Δf_{OOB}	Δ Frequency of Out Of Band emission
$\Delta MB_{P,n}$	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
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
$\Delta R_{IB,P,n}$	Allowed relaxation to each, minimum peak EIRP and reference sensitivity due to support for inter-band CA operation, per band in a combination of supported bands
$\Delta R_{IB,S,n}$	Allowed relaxation to each, EIRP spherical coverage and EIS spherical coverage due to support for inter-band CA 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($BW_{GB,Channel(k)}$)
$BW_{GB,Channel(k)}$	Minimum guardband defined in clause 5.3A.2 of carrier k
$BW_{interferer}$	Bandwidth of the interferer
Ceil(x)	Rounding upwards; ceil(x) is the smallest integer such that ceil(x) $\geq$ x
$EIRP_{max}$	The applicable maximum EIRP as specified in clause 6.2.1
$EIRP_1$	The measured total EIRP based on the beam the UE chooses autonomously (corresponding beam) to transmit in the direction of the incoming DL signal, which is based on beam correspondence without relying on UL beam sweeping
$EIRP_2$	The measured total EIRP based on the beam yielding highest EIRP in a given direction, which is based on beam correspondence with relying on UL beam sweeping
F_C	*RF reference frequency* for the carrier center 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.
$F_{C, high}$	The Fc of the highest carrier, expressed in MHz.
$F_{C, low}$	The Fc of the lowest carrier, expressed in MHz.
F_{DL_high}	The highest frequency of the downlink *operating band*
F_{DL_low}	The lowest frequency of the downlink *operating band*
$F_{edge,block,high}$	The upper sub-block edge, where $F_{edge,block,high} = F_{C,block,high} + F_{offset, high}$.
$F_{edge,block,low}$	The lower sub-block edge, where $F_{edge,block,low} = F_{C,block,low} - F_{offset, low}$.
$F_{edge, high}$	The upper edge of *Aggregated Channel Bandwidth*, expressed in MHz. $F_{edge, high} = F_{C, high} + F_{offset, high}$.
$F_{edge, low}$	The lower edge of *Aggregated Channel Bandwidth*, expressed in MHz. $F_{edge, low} = F_{C, low} - F_{offset, low}$.
$F_{Interferer}$	Frequency of the interferer
$F_{Interferer}$ (offset)	Frequency offset of the interferer (between the center frequency of the interferer and the carrier frequency of the carrier measured)
$F_{Ioffset}$	Frequency offset of the interferer (between the center frequency of the interferer and the closest edge of the carrier measured)
Floor(x)	Rounding downwards; floor(x) is the greatest integer such that floor(x) $\leq$ x
F_{OOB}	The boundary between the NR out of band emission and spurious emission domains
$F_{offset, high}$	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
$F_{offset, low}$	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_{REF}	RF reference frequency
$F_{REF-Offs}$	Offset used for calculating F_{REF}

F_{UL_high}	The highest frequency of the uplink *operating band*
F_{UL_low}	The lowest frequency of the uplink *operating band*
F_{UL_Meas}	The sub-carrier frequency for which the equalizer coefficient is evaluated
F_center	The center frequency of an allocated block of PRBs
$GB_{Channel}$	Minimum guardband defined in 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
NR_{ACLR}	NR ACLR
N_{RB}	Transmission bandwidth configuration, expressed in units of resource blocks
$N_{RB,high}$	Transmission bandwidth configurations according to Table 5.3.2-1 for the highest assigned component carrier in clause 5.3A.1
$N_{RB,low}$	Transmission bandwidth configurations according to Table 5.3.2-1 for the lowest assigned component carrier in clause 5.3A.1
N_{REF}	NR Absolute Radio Frequency Channel Number (NR-ARFCN)
$N_{REF-Offs}$	Offset used for calculating N_{REF}
n_{PRB}	Physical resource block number
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_{int}	The intermediate power point as defined in Table 6.3.4.2.3-2
$P_{Interferer}$	Modulated mean power of the interferer
P_{max}	The maximum UE output power as specified in clause 6.2.1
P_{min}	The minimum UE output power as specified in clause 6.3.1
$P_{PowerClass}$	Nominal UE power class (i.e., no tolerance) as specified in 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
$P\text{-}MPR_{f,c}$	The Power Management UE Maximum Power Reduction for carrier *f* of serving cell *c*
RB_{start}	Indicates the lowest RB index of transmitted resource blocks
SCS_{high}	SCS for the highest assigned component carrier in clause 5.3A.1
SCS_{low}	SCS for the lowest assigned component carrier in clause 5.3A.1
SS_{REF}	SS block reference frequency position
TRP_{max}	The maximum TRP for the UE power class as specified in clause 6.2.1
$T(\Delta P)$	The tolerance $T(\Delta P)$ for applicable values of ΔP (values in dB)

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].

ACLR	Adjacent Channel Leakage Ratio
ACS	Adjacent Channel Selectivity
AoA	Angle of Arrival
A-MPR	Additional Maximum Power Reduction
BCS	Bandwidth Combination Set
BPSK	Binary Phase-Shift Keying
BS	Base Station
BW	Bandwidth
BWP	Bandwidth Part
CA	Carrier Aggregation
CABW	Cumulative Aggregated Channel Bandwidth
CA_nX-nY	Inter-band CA of component carrier(s) in one sub-block within Band nX and component carrier(s) in one sub-block within Band nY where nX and nY are the applicable NR *operating band*

CC	Component Carrier
CDF	Cumulative Distribution Function
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 Range
FWA	Fixed Wireless Access
GSCN	Global Synchronization Channel Number
IBB	In-band Blocking
IBM	Independent Beam Management
IDFT	Inverse Discrete Fourier Transformation
ITU-R	Radio communication Sector of the International Telecommunication Union
MBW	Measurement bandwidth defined for the protected band
MPR	Allowed maximum power reduction
NR	New Radio
NR/5GC	NR connected to 5GC
NR-ARFCN	NR Absolute Radio Frequency Channel Number
NS	Network Signalling
OCNG	OFDMA Channel Noise Generator
OOB	Out-of-band
OTA	Over The Air
PRB	Physical Resource Block
P-MPR	Power Management Maximum Power Reduction
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 / System Simulator
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
ULFPTx	Uplink Full Power 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 (MU). The measurement uncertainty defines in TR 38.903 [20]. The present document defines test tolerances (TT). These test tolerances are individually calculated for each test. The test tolerances are used to relax the minimum requirements in the TS 38.101-2 [3] 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 various levels of "Shared Risk" principle as described below.

a) Core specification value is not relaxed by any relaxation value (TT=0). For each single measurement, the probability of a borderline good UE being judged as FAIL equals the probability of a borderline bad UE being judged as PASS.

   - Test tolerances equal to 0 (TT=0) are considered in this specification.

b) Core specification value is relaxed by a relaxation value (TT>0). For each single measurement, the probability of a borderline bad UE being judged as PASS is greater than the probability of a borderline good UE being judged as FAIL.

   - Test tolerances lower than measurement uncertainty and greater than 0 (0 < TT < MU) are considered in this specification.

   - Test tolerances high up to measurement uncertainty (TT = MU) are considered in this specification which is also known as “Never fail a good DUT” principle.

c) Core specification value is tightened by a stringent value (TT<0). For each single measurement, the probability of a borderline good UE being judged as FAIL is greater than the probability of a borderline bad UE being judged as PASS.

   - Test tolerances lower than 0 (TT<0) are not considered in this specification.

The “Never fail a good DUT” and the “Shared Risk” principles are 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 slot format indicated by TDD-UL-DL-ConfigurationCommon and TDD-UL-DL-ConfigurationDedicated in the PCell and SCells for NR/5GC.

For FR2 intra-band CA configurations with multiple FR2 sub-blocks, where at least one of the sub-blocks is a contiguous CA configuration:

- if the field *partialFR2-FallbackRX-Req* is not present, the UE shall meet all applicable UE RF requirements for the highest order CA configuration and all associated fallback CA configurations;
- if the field *partialFR2-FallbackRX-Req* is present, for each FR2 intra-band CA configuration with multiple sub-blocks that the UE indicates support for explicitly in UE capability signalling: the in-gap UE RF requirements in clauses 7.5A, 7.5D, 7.6A, 7.6D apply as the equivalent requirements for the associated fallback CA configurations with the same number of sub-blocks, where at least one of the sub-blocks consists of a contiguous CA configuration. The UE shall meet all applicable UE RF requirements for fallback CA configurations with a lesser number of sub-blocks;
- regardless of the field *partialFR2-FallbackRX-Req*, the UE shall meet all DL out-of-gap requirements for all lower order fallback CA configurations.

4.3 Specification suffix information

Unless stated otherwise the following suffixes are used for indicating at 2nd level clause, 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.

4.5 Applicability and test coverage rules

The applicability and test coverage rules for NR/5GC and EN-DC capable devices shall include the following:

If a test case for a FR2 NR band in a device is tested in EN-DC mode for non-exceptional requirement as per TS 38.521-3 [14], it shall fulfil the coverage requirement for that test case for NR/5GC FR2 test requirements for that NR band and need not be retested.

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	410 MHz – 7125 MHz
FR2	24250 MHz – 52600 MHz

This test specification covers FR2 operating bands.

For the purpose of derivation of Maximum Test System Uncertainty (MTSU) in Annex F, the frequency range FR2 is further divided into sub-ranges as shown in Table 5.1-2. These FR2 sub-ranges are also referred to as part of definition of test tolerance within the individual test cases.

Table 5.1-2: Definition of frequency sub-ranges

Frequency sub-range designation	Corresponding frequency range
FR2a	23.45 GHz ≤ f < 32.125 GHz
FR2b	32.125 GHz ≤ f < 40.8 GHz
FR2c	40.8GHz ≤ f < 44.3GHz
FR2d	44.3 GHz ≤ f < 49.0 GHz

5.2 Operating bands

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

Table 5.2-1: NR operating bands in FR2

Operating Band	Uplink (UL) operating band BS receive UE transmit			Downlink (DL) operating band BS transmit UE receive			Duplex Mode
	F_{UL_low} – F_{UL_high}			F_{DL_low} – F_{DL_high}			
n257	26500 MHz	–	29500 MHz	26500 MHz	–	29500 MHz	TDD
n258	24250 MHz	–	27500 MHz	24250 MHz	–	27500 MHz	TDD
n259	39500 MHz	–	43500 MHz	39500 MHz	–	43500 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 and non-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 and non-contiguous CA operating bands in FR2

NR CA Band	NR Band (Table 5.2-1)
CA_n257	n257
CA_n260	n260
CA_n261	n261

5.2A.2 Void

5.2A.3 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.

Beam management type is according to UE capability declaration *IE beamManagementType-r16*. The requirements in the following clauses are only applicable to inter-band CA with IBM type.

Table 5.2A.3-1: Inter-band CA operating bands in FR2

NR CA Band	NR Band (Table 5.2-1)
CA_n260-n261	n260, n261

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
n259
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.

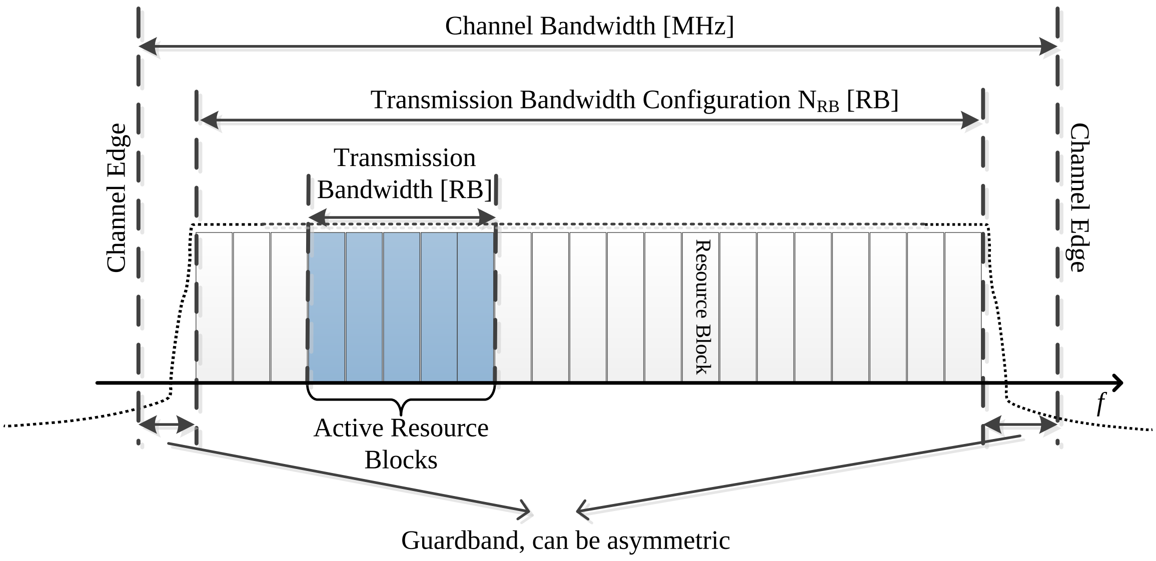

Figure 5.3.1-1: Definition of channel bandwidth and transmission bandwidth configuration for one NR channel

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)	50 MHz	100 MHz	200 MHz	400 MHz
	N_{RB}	N_{RB}	N_{RB}	N_{RB}
60	66	132	264	N/A
120	32	66	132	264

5.3.3 Minimum guardband and transmission bandwidth configuration

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

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

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

NOTE: The minimum guardbands have been calculated using the following equation: ($BW_{Channel}$ x 1000 (kHz) - N_{RB} x SCS x 12) / 2 - SCS/2, where N_{RB} 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 guardband specified in this clause is met.

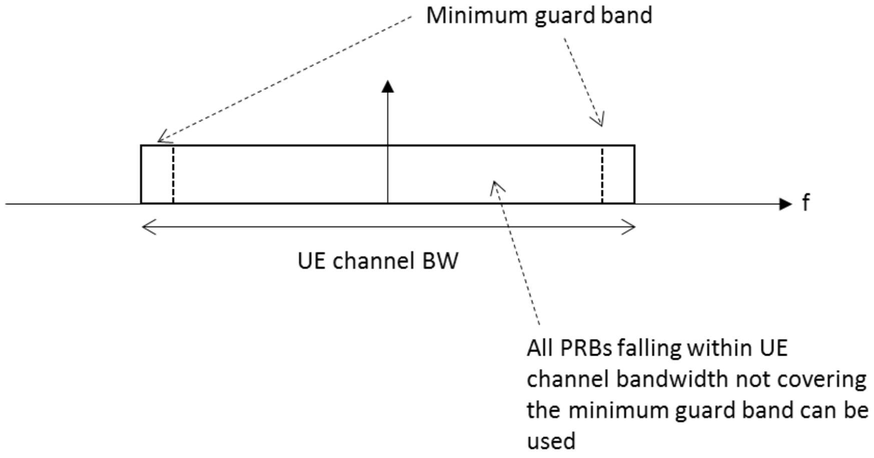

Figure 5.3.3-2: UE PRB utilization

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

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

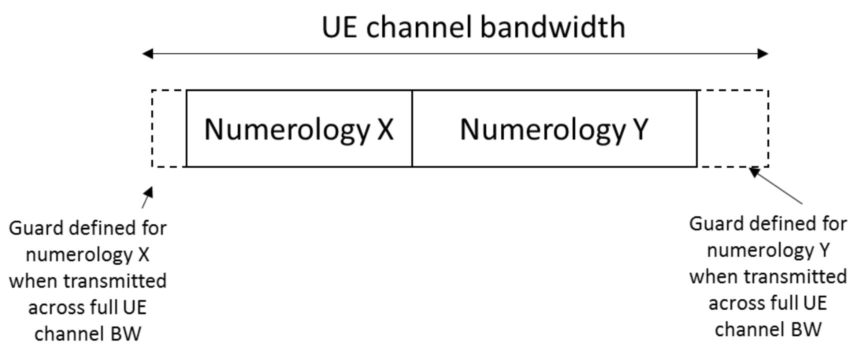

Figure 5.3.3-3: Guardband definition when transmitting multiple numerologies

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

5.3.4 RB alignment

For each numerology, its common resource blocks are specified in clause 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 *UE transmission bandwidth configuration* is indicated by the higher layer parameter *carrierBandwidth* [19] and will fulfil the minimum UE guardband requirement specified in clause 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[2] 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
n259	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. NOTE 2: This UE channel bandwidth is optional in this release of the specification.					

5.3A UE Channel bandwidth for CA

5.3A.1 General

TBD

5.3A.2 Minimum guardband 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.

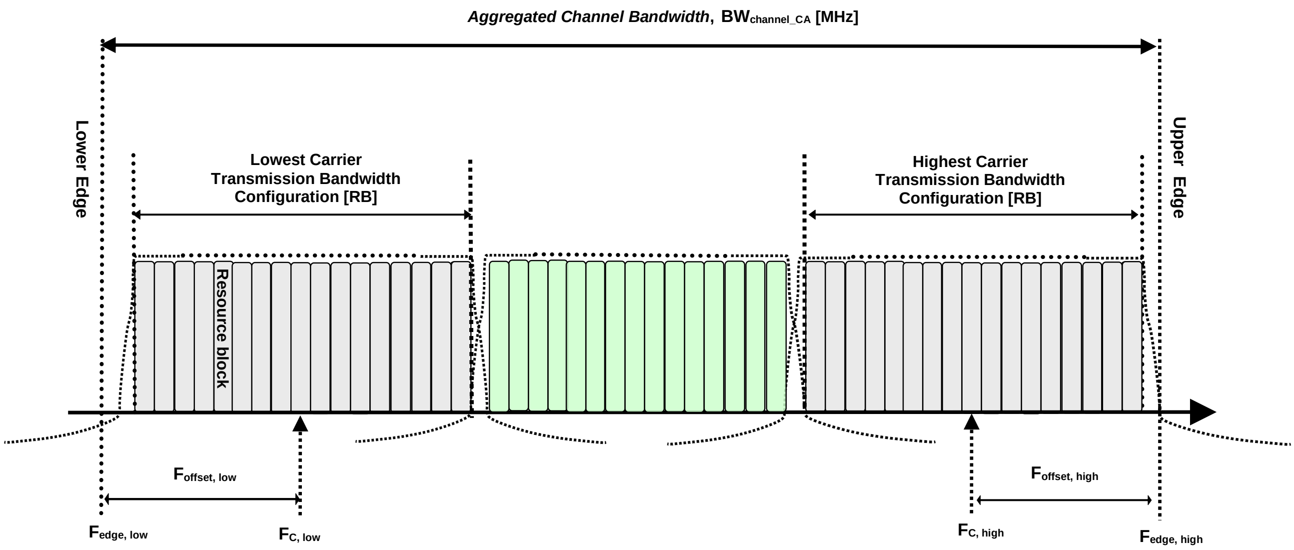

Figure 5.3A.2-1: Definition of *Aggregated Channel Bandwidth* for intra-band carrier aggregation

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

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

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

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

$N_{RB,low}$ 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. SCS_{low}, SCS_{high}, $N_{RB,low}$, $N_{RB,high}$, and $BW_{GB,Channel(k)}$ use the largest μ value among the subcarrier spacing configurations supported in the operating band for both of the channel bandwidths according to Table 5.3.5-1 and $BW_{GB,Channel(k)}$ is the minimum guard band for carrier k according to Table 5.3.3-1 for the said μ value.

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

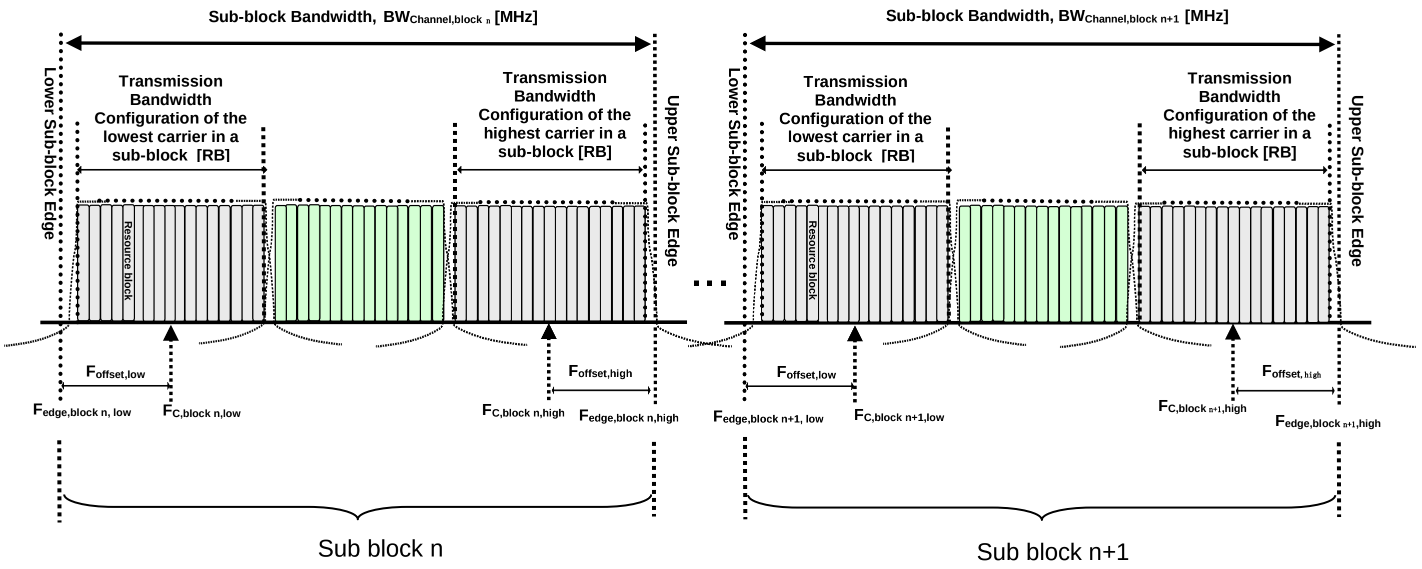

Figure 5.3A.2-2: Definition of sub-block bandwidth for intra-band non-contiguous spectrum

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}, SCS_{high}, $N_{RB,low}$, $N_{RB,high}$, and $BW_{GB,Channel(k)}$ use the largest μ value among the subcarrier spacing configurations supported in the operating band for both of the channel bandwidths according to Table 5.3.5-1 and $BW_{GB,Channel(k)}$ is the minimum guard band for carrier k according to Table 5.3.3-1 for the said μ value.SCS_{low} and SCS_{high} are the sub-carrier spacing for the lowest and highest assigned component carrier within a sub-block, respectively.

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, UE can indicate support of several bandwidth combination sets per carrier aggregation configuration. The requirements are applicable only when Uplink CCs are configured within the frequency range between lower edge of lowest downlink component carrier and upper edge of highest downlink component carrier.

For intra-band non-contiguous downlink carrier aggregation, a carrier aggregation configuration is a single operating band supporting two or more sub-blocks, each supporting a carrier aggregation bandwidth class. The requirements are applicable only when Uplink CCs are configured within the frequency range between lower edge of lowest downlink component carrier and upper edge of highest downlink component carrier.

Frequency separation class specified in Table 5.3A.4-2 indicates the maximum frequency span between lower edge of lowest component carrier and upper edge of highest component carrier that UE can support per band in downlink or uplink respectively in non-contiguous intra-band operation.

The DL-only frequency spectrum is the width of UE frequency spectrum available to network to configure DL CCs only, and it extends on one-side of the bidirectional spectrum in contiguous manner with no frequency gap between the two. Frequency separation class for DL-only spectrum (Fsd) specified in Table 5.3A.4-3 and is declared per band. The frequency separation class for DL-only spectrum (Fsd) can be equal but not larger than the frequency separation (DL Fs). The combined downlink spectrum (DL Fs + Fsd) cannot exceed 2400 MHz. A UE may configure DL-only spectrum only if the combined downlink spectrum (DL Fs + Fsd) exceeds 1400 MHz. When a UE configures DL-only spectrum, it shall not expect a CC to be configured across the boundary between bidirectional spectrum and DL-only spectrum UE can support respectively.

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

Table 5.3A.4-1: CA bandwidth classes

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

Table 5.3A.4-2: Frequency separation classes for non-contiguous intra-band operation

Frequency separation class	Max. allowed frequency separation (Fs)
I	800 MHz
II	1200 MHz
III	Fs1400 MHz
IV	1000 MHz
V	1600 MHz
VI	1800 MHz
VII	2000 MHz
VIII	2200 MHz
IX	2400 MHz
X	400 MHz
XI	600 MHz
NOTE 1: Fs values larger than 1400 MHz apply only to downlink frequency separation.	

Table 5.3A.4-3: Frequency separation classes for DL-only spectrum

Frequency separation class	Max. allowed frequency separation (Fsd)
I	200 MHz
II	400 MHz
III	600 MHz
IV	800 MHz
V	1000 MHz
VI	1200 MHz

5.3D Channel bandwidth for UL MIMO

The requirements specified in clause 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,

$$\text{Nominal Channel spacing} = (BW_{Channel(1)} + BW_{Channel(2)})/2 + \{-20\text{ kHz}, 0\text{ kHz}, 20\text{ kHz}\} \text{ for } \Delta F_{Raster} \text{ equals to 60 kHz}$$

$$\text{Nominal Channel spacing} = (BW_{Channel(1)} + BW_{Channel(2)})/2 + \{-40\text{ kHz}, 0\text{ kHz}, 40\text{ kHz}\} \text{ for } \Delta F_{Raster} \text{ equals to 120 kHz}$$

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

5.4.2 Channel raster

5.4.2.1 NR-ARFCN and channel raster

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

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

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

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

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

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

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

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 $I \in \{1,2\}$. Every I^{th} NR-ARFCN within the operating band are applicable for the channel raster within the operating band and the step size for the channel raster in Table 5.4.2.3-1 is given as <*I*>.

- In frequency bands with two ΔF_{Raster}, the higher ΔF_{Raster} applies to channels using only the SCS that is equal to the higher ΔF_{Raster} and the SSB SCS that is equal to or larger than 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
n259	60	2270833 – <1> – 2337499
	120	2270833– <2> – 2337499
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 * 17.28 MHz, N = 0: 4383	22256+ N	22256 – 26639

5.4.3.2 Synchronization raster to synchronization block resource element mapping

The mapping between the synchronization raster and the corresponding resource element of the SS block is given in Table 5.4.3.2-1.

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

Resource element index *k*	120

k is the subcarrier number of SS/PBCH block defined in TS 38.211 [9] clause 7.4.3.1.

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
n259	120 kHz	Case D	23140 – <1> – 23369
	240 kHz	Case E	23142 – <2> – 23368
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

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

$$n = \mu_0 - 2$$

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, μ_o is the largest μ value among the subcarrier spacing configurations supported in the operating band for both of the channel bandwidths according to Table 5.3.5-1, and $GB_{Channel(i)}$ is the minimum guardband for channel bandwidth *i* according to Table 5.3.3-1 for the said μ value, with μ as defined in TS 38.211 [9].

The channel spacing for intra-band contiguous carrier aggregation can be adjusted to any multiple of sub-carrier spacing less than the nominal channel spacing to optimize performance in a particular deployment scenario.

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

5.5 Configurations

5.5A Configurations for CA

5.5A.1 Configurations for intra-band contiguous CA

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

NR CA configuration	Uplink CA configurations	$BW_{Channel}$ (MHz)	$BW_{Channel}$ (MHz)	$BW_{Channel}$ (MHz)	$BW_{Channel}$ (MHz)	$BW_{Channel}$ (MHz)	$BW_{Channel}$ (MHz)	$BW_{Channel}$ (MHz)	$BW_{Channel}$ (MHz)	Maximum aggregated BW (MHz)	BCS	Fallback group
CA_n257B	CA_n257B	50, 100, 200, 400	400							800	0	1
CA_n257D	CA_n257D	50, 100, 200,	200							400	0	
CA_n257E	CA_n257E	50, 100, 200,	200	200						600	0	2
CA_n257F	CA_n257F	50, 100, 200,	200	200	200					800	0	
CA_n257G	CA_n257G	50, 100	100							200	0	
CA_n257H	CA_n257H	50, 100	100	100						300	0	
CA_n257I	CA_n257I	50, 100	100	100	100					400	0	
CA_n257J	CA_n257J	50, 100	100	100	100	100				500	0	3
CA_n257K	CA_n257K	50, 100	100	100	100	100	100			600	0	
CA_n257L	CA_n257L	50, 100	100	100	100	100	100	100		700	0	
CA_n257M	CA_n257M	50, 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	
CA_n260E	CA_n260E	50, 100, 200	200	200						600	0	2
CA_n260F	CA_n260F	50, 100, 200	200	200	200					800	0	
CA_n260G	CA_n260G	50, 100	100							200	0	
CA_n260H	CA_n260H	50, 100	100	100						300	0	
CA_n260I	CA_n260I	50, 100	100	100	100					400	0	
CA_n260J	CA_n260J	50, 100	100	100	100	100				500	0	3
CA_n260K	CA_n260K	50, 100	100	100	100	100	100			600	0	
CA_n260L	CA_n260L	50, 100	100	100	100	100	100	100		700	0	
CA_n260M	CA_n260M	50, 100	100	100	100	100	100	100	100	800	0	
CA_n260O	CA_n260O	50, 100	50, 100							200	0	
CA_n260P	CA_n260P	50, 100	50, 100	50, 100						300	0	4
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	400	400						850[1]	0	
CA_n261D	CA_n261D	50, 100, 200	200							400	0	
CA_n261E	CA_n261E	50, 100, 200	200	200						600	0	2
CA_n261F	CA_n261F	50, 100, 200	200	200	200					800	0	
CA_n261G	CA_n261G	50, 100	100							200	0	
CA_n261H	CA_n261H	50, 100	100	100						300	0	
CA_n261I	CA_n261I	50, 100	100	100	100					400	0	3
CA_n261J	CA_n261J	50, 100	100	100	100	100				500	0	
CA_n261K	CA_n261K	50, 100	100	100	100	100	100			600	0	

NR CA configuration	Uplink CA configurations	$BW_{Channel}$ (MHz)	$BW_{Channel}$ (MHz)	$BW_{Channel}$ (MHz)	$BW_{Channel}$ (MHz)	$BW_{Channel}$ (MHz)	$BW_{Channel}$ (MHz)	$BW_{Channel}$ (MHz)	$BW_{Channel}$ (MHz)	Maximum aggregated BW (MHz)	BCS	Fallback group
CA_n261L	CA_n261L	50, 100	100	100	100	100	100	100		700	0	
CA_n261M	CA_n261M	50, 100	100	100	100	100	100	100	100	800	0	
CA_n261O	CA_n261O	50, 100	50, 100							200	0	
CA_n261P	CA_n261P	50, 100	50, 100	50, 100						300	0	4
CA_n261Q	CA_n261Q	50, 100	50, 100,	50, 100	50, 100					400	0	

NOTE 1: Void.
NOTE 2: For the NR CA configuration with more than two component carries, the bandwidths in a BCS which may introduce combinations more than requested unintentionally should be listed in a row separately.

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

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

NOTE: Sub-blocks belonging to a CA configuration can be in any order. In other words certain CA configuration acronym includes all sub-block arrangements which have exactly the same sub-block set. As an example, CA_n260(2G-3O) denotes CA_n260(2O-2G-O), CA_n260(G-3O-G) etc. but these are not listed in tables separately.

Table 5.5A.2-1: NR CA configurations with single CA bandwidth class defined for intra-band non-contiguous CA

NR configuration	Uplink CA configurations	Sub-block	Sub-block	Sub-block	Sub-block	Sub-block	Sub-block	Sub-block	Sub-block	$\Sigma(BW_{Channel,block})$ (MHz)	BCS
CA_n257(2A)	-	n257A	n257A							800	0
CA_n260(2A)	-	n260A	n260A							800	0
CA_n260(3A)	-	n260A	n260A	n260A						1200	0
CA_n260(4A)	-	n260A	n260A	n260A	n260A					1600	0
CA_n261(2A)	-	n261A	n261A							800	0
CA_n261(3A)	-	n261A	n261A	n261A						800	0
CA_n261(4A)	-	n261A	n261A	n261A	n261A					800	0

NOTE 1: Void
NOTE 2: Void
NOTE 3: Void
NOTE 4: Channel bandwidth per operating band defined in Table 5.3.5-1.
NOTE 5: Void.
NOTE 6: Void.
NOTE 7: $\Sigma(BW_{Channel,block})$ denotes the maximum total bandwidth from the summation of the sub-block bandwidths and shall be less than the bandwidth of the operating band.
NOTE 8: Unless otherwise stated, BCS0 is referred in each constituent CA configuration.

Table 5.5A.2-2: NR CA configurations with multiple CA bandwidth classes defined for intra-band non-contiguous CA

CA configuration	Uplink CA configurations	Sub-block	Sub-block	Sub-block	Sub-block	Sub-block	Sub-block	Sub-block	$\Sigma(BW_{Channel,block})$ (MHz)	BCS
CA_n260(A-I)	CA_n260I	n260A	CA_n260I						800	0
CA_n260(D-G)	CA_n260D CA_n260G	CA_n260D	CA_n260G						600	0
CA_n260(D-H)	CA_n260D CA_n260H	CA_n260D	CA_n260H						700	0
CA_n260(D-I)	CA_n260D CA_n260I	CA_n260D	CA_n260I						800	0
CA_n260(D-O)	CA_n260D CA_n260O	CA_n260D	CA_n260O						600	0
CA_n260(D-P)	CA_n260D CA_n260P	CA_n260D	CA_n260P						700	0
CA_n260(D-Q)	CA_n260D CA_n260Q	CA_n260D	CA_n260Q						800	0
CA_n260(E-O)	CA_n260E CA_n260O	CA_n260O	CA_n260E						800	0
CA_n260(E-P)	CA_n260E CA_n260P	CA_n260E	CA_n260P						800	0
CA_n260(E-Q)	CA_n260E CA_n260Q	CA_n260E	CA_n260Q						1000	0
CA_n260(G-I)	CA_n260G CA_n260I	CA_n260G	CA_n260I						600	0

CA_n261(D-G)	CA_n261D CA_n261G	CA_n26 1D	CA_n26 1G						600	0
CA_n261(D-H)	CA_n261D CA_n261H	CA_n26 1D	CA_n26 1H						700	0
CA_n261(D-I)	CA_n261D CA_n261I	CA_n26 1D	CA_n26 1I						800	0
CA_n261(D-O)	CA_n261D CA_n261O	CA_n26 1D	CA_n26 1O						600	0
CA_n261(D-P)	CA_n261D CA_n261P	CA_n26 1D	CA_n26 1P						700	0
CA_n261(D-Q)	CA_n261D CA_n261Q	CA_n26 1D	CA_n26 1Q						800	0
CA_n261(E-O)	CA_n261E CA_n261O	CA_n26 1E	CA_n26 1O						800	0
CA_n261(E-P)	CA_n261E CA_n261P	CA_n26 1E	CA_n26 1P						800	0
CA_n261(E-Q)	CA_n261E CA_n261Q	CA_n26 1E	CA_n26 1Q						800[1]	0

NOTE 1: Void
NOTE 2: Void
NOTE 3: Unless otherwise stated, BCS0 is referred to, in each constituent CA configuration.
NOTE 4: Void.
NOTE 5: Void.
NOTE 6: Void.
NOTE 7: $\Sigma(BW_{Channel,block})$ denotes the maximum total bandwidth from the summation of the sub-block bandwidths and shall be less than the bandwidth of the operating band.
NOTE 8: Channel bandwidth per operating band is defined in Table 5.3.5-1.
NOTE 9: Configurations for intra-band contiguous CA are defined in Table 5.5A.1-1.
NOTE 10: Configurations for intra-band non-contiguous CA are defined in Table 5.5A.2-1.

5.5A.3 Configurations for inter-band CA

Table 5.5A.3-1: NR CA configurations for inter-band CA

NR CA configuration	Uplink CA configuration	NR Band	Channel bandwidth (MHz) (NOTE 1)				Bandwidth combination set
			50	**100**	**200**	**400**	
CA_n260A-n261A	-	n260	50	100	200	400	0
		n261	50	100	200	400	
NOTE 1: The SCS of each channel bandwidth for NR band refers to Table 5.3.5-1.							

5.5D Configurations for UL MIMO

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