# 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](http://www.3gpp.org/DynaReport/38508-1.htm): "5GS; User Equipment (UE) conformance specification; Part 1: Common test environment".

[11] 3GPP TS [38.508-](http://www.3gpp.org/DynaReport/38508-1.htm)2: "5GS; User Equipment (UE) conformance specification; Part 2: Common Implementation Conformance Statement (ICS) proforma".

[12] 3GPP TS [38.50](http://www.3gpp.org/DynaReport/38508-1.htm)9: "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 [38.5](http://www.3gpp.org/DynaReport/38508-1.htm)22: "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.

**Bidirectional spectrum:** UL/DL common spectrum in which the UE supports the configuration of uplink or downlink CCs.

**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.

**FWA UE:** A UE intended to be used in fixed wireless access scenario.

**Handheld UE:** A UE intended to be used in handheld scenario.

**IBM (Independent Beam Management):** A UE that supports inter-band CA with IBM selects its DL and UL 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.

**RedCap UE: The UE with reduced capabilities as defined in clause 4.2.21.1 from TS38.306 [26]**

**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:

∆EIRPBC The beam correspondence tolerance, where ∆EIRPBC = EIRP2 – EIRP1

ΔFGlobal Granularity of the global frequency raster

ΔFRaster Band dependent channel raster granularity

ΔfOOB Δ Frequency of Out Of Band emission

ΔMBP,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

ΔMBS,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

ΔRB The starting frequency offset between the allocated RB and the measured non-allocated RB

ΔRIB Allowed reference sensitivity relaxation due to support for inter-band CA operation

ΔRIBC Allowed reference sensitivity relaxation due to support for intra-band contiguous CA operation

ΔRIBNC Allowed reference sensitivity relaxation due to support for intra-band non-contiguous CA operation

ΔRIB,P,n Allowed relaxation to reference sensitivity due to support for inter-band CA operation, per band in a combination of supported bands

ΔTIB Allowed relaxation to EIRP requirements due to support for inter-band CA operation

ΔTIB,P,n Allowed relaxation to peak EIRP requirements due to support for inter-band CA operation, per supported band in a combination.

ΔTIB,S,n Allowed relaxation to EIRP spherical coverage due to support for inter-band CA operation, per supported band in a combination.

ΔRIB,S,n Allowed relaxation to EIS spherical coverage due to support for inter-band CA operation, per band in a combination of supported bands

∑MBP 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

∑MBS 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

BWChannel Channel bandwidth

BWChannel\_CA Aggregated channel bandwidth, expressed in MHz.

BWGB max( BWGB,Channel(k) )

BWGB,Channel(k) Minimum guardband defined in clause 5.3A.2 of carrier k

BWinterferer Bandwidth of the interferer

Ceil(x) Rounding upwards; ceil(x) is the smallest integer such that ceil(x) ≥ x

EIRPmax The applicable maximum EIRP as specified in clause 6.2.1

EIRP1 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

EIRP2 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

FC *RF reference frequency* for the carrier center on the channel raster, given in table 5.4.2.2-1

FC,block, high Fc of the highest transmitted/received carrier in a sub-block.

FC,block, low Fc of the lowest transmitted/received carrier in a sub-block.

FC, high The Fc of the highest carrier, expressed in MHz.

FC, low The Fc of the lowest carrier, expressed in MHz.

FDL\_high The highest frequency of the downlink *operating band*

FDL\_low The lowest frequency of the downlink *operating band*

Fedge,block,high The upper sub-block edge, where Fedge,block,high = FC,block,high + Foffset, high.

Fedge,block,low The lower sub-block edge, where Fedge,block,low = FC,block,low - Foffset, low.

Fedge, high The upper edge of *Aggregated* *Channel Bandwidth*, expressed in MHz. Fedge, high = FC, high + Foffset, high.

Fedge, low The lower edge of *Aggregated Channel Bandwidth*, expressed in MHz. Fedge, low = FC, low - Foffset, low.

FInterferer Frequency of the interferer

FInterferer (offset) Frequency offset of the interferer (between the center frequency of the interferer and the carrier frequency of the carrier measured)

FIoffset 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) ≤ x

FOOB The boundary between the NR out of band emission and spurious emission domains

Foffset, high Frequency offset from FC, high to the upper *UE RF Bandwidth edge*, or from FC,block, high to the upper sub-block edge

Foffset, low Frequency offset from FC, low to the lower *UE RF Bandwidth edge*, or from FC,block, low to the lower sub-block edge

FREF RF reference frequency

FREF-Offs Offset used for calculating FREF

FUL\_high The highest frequency of the uplink *operating band*

FUL\_low The lowest frequency of the uplink *operating band*

FUL\_Meas The sub-carrier frequency for which the equalizer coefficient is evaluated

F\_center The center frequency of an allocated block of PRBs

GBChannel Minimum guardband defined in clause 5.3.3, expressed in kHz

LCRB Transmission bandwidth which represents the length of a contiguous resource block allocation expressed in units of resources blocks

LCRB,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

MPRf,c Maximum output power reduction for carrier *f* of serving cell *c*

MPRnarrow Maximum output power reduction due to narrow PRB allocation

MPRWT Maximum power reduction due to modulation orders, transmit bandwidth configurations, waveform types

NRACLR NR ACLR

NRB Transmission bandwidth configuration, expressed in units of resource blocks

NRB,high Transmission bandwidth configurations according to Table 5.3.2-1 for the highest assigned component carrier in clause 5.3A.1

NRB,low Transmission bandwidth configurations according to Table 5.3.2-1 for the lowest assigned component carrier in clause 5.3A.1

NREF NR Absolute Radio Frequency Channel Number (NR-ARFCN)

NREF-Offs Offset used for calculating NREF

*n*PRB Physical resource block number

PCMAX The configured maximum UE output power

PCMAX, *f*, *c* The configured maximum UE output power for carrier *f* of serving cell *c*

Pint The intermediate power point as defined in Table 6.3.4.2.3-2

PInterferer Modulated mean power of the interferer

Pmax The maximum UE output power as specified in clause 6.2.1

Pmin The minimum UE output power as specified in clause 6.3.1

PPowerClass Nominal UE power class (i.e., no tolerance) as specified in clause 6.2.1

PRB The transmitted power per allocated RB, measured in dBm

PTMAX,f,c The measured total radiated power for carrier *f* of serving cell *c*

PUMAX The measured configured maximum UE output power

Pw Power of a wanted DL signal

P-MPRf,c The Power Management UE Maximum Power Reduction for carrier *f* of serving cell *c*

RBstart Indicates the lowest RB index of transmitted resource blocks

SCShigh SCS for the highest assigned component carrier in clause 5.3A.1, expressed in kHz

SCSlow SCS for the lowest assigned component carrier in clause 5.3A.1, expressed in kHz

SSREF SS block reference frequency position

TRPmax The maximum TRP for the UE power class as specified in clause 6.2.1

T(∆P) The tolerance T(∆P) for applicable values of ∆P (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

RedCap Reduced Capability

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 | |
| FR2c1 | | 40.8GHz ≤ f < 44.3GHz | |
| FR2d | | 44.3 GHz ≤ f < 49.0 GHz | |
| NOTE 1: MTSU/TT/relaxation for FR2c is applied to all over the frequency range of n259. | | | |

## 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 | | |
|  | | | | FUL\_low – FUL\_high | | | | | FDL\_low – FDL\_high | | | | |  | | |
| n257 | | | | 26500 MHz | – | 29500 MHz | | | 26500 MHz | – | 29500 MHz | | | TDD | | |
| n258 | | | | 24250 MHz | – | 27500 MHz | | | 24250 MHz | – | 27500 MHz | | | TDD | | |
| n2591 | | | | 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 | | |
| NOTE 1: MTSU/TT/relaxation for FR2c is applied to all over the frequency range of n259. | | | | | | | | | | | | | | | | |

## 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\_n258 | n258 |
| 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 NRB 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 NRB

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SCS (kHz) | 50 MHz | 100 MHz | 200 MHz | 400 MHz |
| NRB | NRB | NRB | NRB |
| 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: GBchannel = (BWChannel x 1000 (kHz) - NRB x SCS x 12) / 2 - SCS/2, where NRB are from Table 5.3.2-1 and GBchannel expressed in kHz.

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.

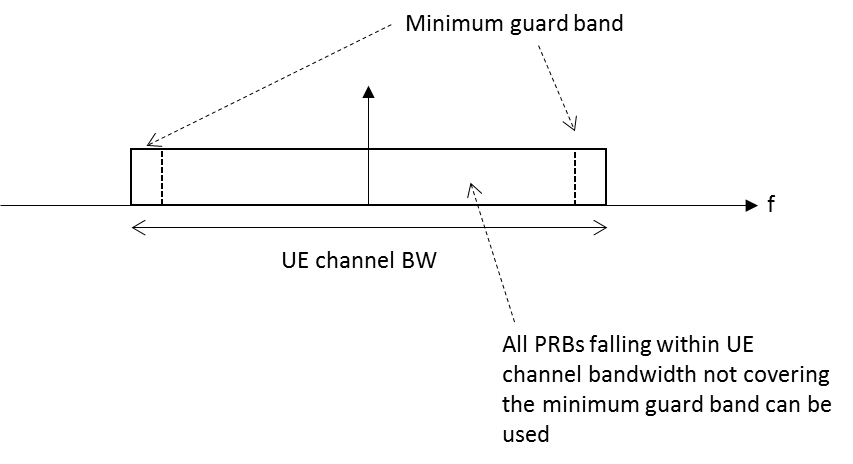


Figure 5.3.3-2: UE PRB utilization

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.

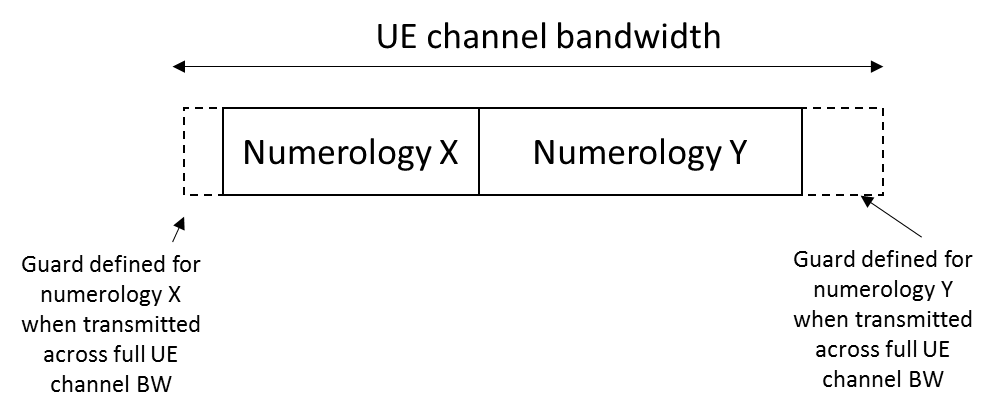


Figure 5.3.3-3: Guardband definition when transmitting multiple numerologies

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 | 4002 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,* BWChannel\_CA, is defined as

BWChannel\_CA = Fedge,high - Fedge,low (MHz).

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

Fedge,low = FC,low - Foffset,low

Fedge,high = FC,high + Foffset,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

Foffset,low = (NRB,low\*12 + 1)\*SCSlow/2 + BWGB (MHz)

Foffset,high = (NRB,high\*12 - 1)\*SCShigh/2 + BWGB (MHz)

BWGB = max(BWGB,Channel(k))

NRB,low and NRB,high are the transmission bandwidth configurations according to Table 5.3.2-1 for the lowest and highest assigned component carrier, SCSlow and SCShigh are the sub-carrier spacing for the lowest and highest assigned component carrier respectively. SCSlow, SCShigh, NRB,low, NRB,high, and BWGB,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 BWGB,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 (BWChannel,block) is defined as

Fedge,block, low = FC,block,low - Foffset, low.

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

Fedge,block,high = FC,block,high + Foffset, high.

The Sub-block Bandwidth, BWChannel,block, is defined as follows:

BWChannel,block = Fedge,block,high - Fedge,block,low (MHz)

The lower and upper frequency offsets Foffset,block,low and Foffset,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

Foffset,block,low = (NRB,low\*12 + 1)\*SCSlow/2 + BWGB (MHz)

Foffset,block,high = (NRB,high\*12 - 1)\*SCShigh/2 + BWGB (MHz)

BWGB = max(BWGB,Channel(k))

where NRB,low and NRB,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. SCSlow, SCShigh, NRB,low, NRB,high, and BWGB,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 BWGB,Channel(k) is the minimum guard band for carrier k according to Table 5.3.3-1 for the said *μ* value.SCSlow and SCShigh 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 Wgap is defined as

Wgap = Fedge,block n+1,low - Fedge,block n,high (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 | BWChannel ≤ 400 MHz | 1 | 1,2,3,4 |
| B | 400 MHz < BWChannel\_CA ≤ 800 MHz | 2 | 1 |
| C | 800 MHz < BWChannel\_CA ≤ 1200 MHz | 3 |
| D | 200 MHz < BWChannel\_CA ≤ 400 MHz | 2 | 2 |
| E | 400 MHz < BWChannel\_CA ≤ 600 MHz | 3 |
| F | 600 MHz < BWChannel\_CA ≤ 800 MHz | 4 |
| G | 100 MHz < BWChannel\_CA ≤ 200 MHz | 2 | 3 |
| H | 200 MHz < BWChannel\_CA ≤ 300 MHz | 3 |
| I | 300 MHz < BWChannel\_CA ≤ 400 MHz | 4 |
| J | 400 MHz < BWChannel\_CA ≤ 500 MHz | 5 |
| K | 500 MHz < BWChannel\_CA ≤ 600 MHz | 6 |
| L | 600 MHz < BWChannel\_CA ≤ 700 MHz | 7 |
| M | 700 MHz < BWChannel\_CA ≤ 800 MHz | 8 |
| O | 100 MHz ≤ BWChannel\_CA ≤200 MHz | 2 | 4 |
| P | 150 MHz ≤ BWChannel\_CA ≤300 MHz | 3 |
| Q | 200 MHz ≤ BWChannel\_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 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,

Nominal Channel spacing = (BWChannel(1) + BWChannel(2))/2 + {-20 kHz, 0 kHz, 20 kHz} for ∆FRaster equals to 60 kHz

Nominal Channel spacing = (BWChannel(1) + BWChannel(2))/2 + {-40 kHz, 0 kHz, 40 kHz} for ∆FRaster equals to 120 kHz

where BWChannel(1) and BWChannel(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 FREF. 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 ΔFGlobal.

*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 FREF in MHz is given by the following equation, where FREF-Offs and NRef-Offs are given in Table 5.4.2.1-1 and NREF is the NR-ARFCN

FREF = FREF-Offs + ΔFGlobal (NREF – NREF-Offs)

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency range (MHz) | ΔFGlobal (kHz) | FREF-Offs (MHz) | NREF-Offs | Range of NREF |
| 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 ΔFRaster, which may be equal to or larger than ΔFGlobal.

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

|  |  |  |
| --- | --- | --- |
|  |  |  |
| Resource element index | 0 | 6 |
| Physical resource block number |  |  |

,  ,  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, ΔFRaster = *I* ×ΔFGlobal, where *I* ϵ *{1,2}*. Every *Ith* 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 ΔFRaster, the higher ΔFRaster applies to channels using only the SCS that is equal to the higher ΔFRaster and the SSB SCS that is equal to or larger than the higher ΔFRaster.

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

|  |  |  |
| --- | --- | --- |
| Operating Band | ΔFRaster  (kHz) | Uplink and Downlink  Range of NREF  (First – <Step size> – Last) |
| n257 | 60 | 2054166 – <1> – 2104165 |
| 120 | 2054167 – <2> – 2104165 |
| n258 | 60 | 2016667 – <1> – 2070832 |
| 120 | 2016667 – <2> – 2070831 |
| 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 SSREF with corresponding number GSCN. The parameters defining the SSREF 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 SSREF 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 SSREF | 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 pattern1 | 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:



with

*n = µ0 – 2*

where BWChannel(1) and BWChannel(2) are the channel bandwidths of the two respective NR component carriers according to Table 5.3.2-1 with values in MHz, o is the largest  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 *GBChannel(i)* isthe minimum guardband for channel bandwidth *i* according to Table 5.3.3-1 for the said  value, with  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 | BWChannel (MHz) | BWChannel (MHz) | BWChannel (MHz) | BWChannel (MHz) | BWChannel (MHz) | BWChannel (MHz) | BWChannel (MHz) | BWChannel (MHz) | Maximum aggregated  BW (MHz) | BCS | Fallback group |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| CA\_n257B | CA\_n257B | 50, 100, 200, 400 | 400 |  |  |  |  |  |  | 800 | 0 | 1 |
| 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 | 3 |
| 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 |
| 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\_n258D | CA\_n258D | 50, 100, 200 | 200 |  |  |  |  |  |  | 400 | 0 |  |
| CA\_n258E | CA\_n258D  CA\_n258E | 50, 100, 200 | 200 | 200 |  |  |  |  |  | 600 | 0 | 2 |
| CA\_n258F | CA\_n258D  CA\_n258E  CA\_n258F | 50, 100, 200 | 200 | 200 | 200 |  |  |  |  | 800 | 0 |  |
| CA\_n258G | CA\_n258G | 50, 100 | 100 |  |  |  |  |  |  | 200 | 0 |  |
| CA\_n258H | CA\_n258G  CA\_n258H | 50, 100 | 100 | 100 |  |  |  |  |  | 300 | 0 |  |
| CA\_n258I | CA\_n258G  CA\_n258H  CA\_n258I | 50, 100 | 100 | 100 | 100 |  |  |  |  | 400 | 0 |  |
| CA\_n258J | CA\_n258G  CA\_n258H  CA\_n258I  CA\_n258J | 50, 100 | 100 | 100 | 100 | 100 |  |  |  | 500 | 0 |  |
| CA\_n258K | CA\_n258G  CA\_n258H  CA\_n258I  CA\_n258J  CA\_n258K | 50, 100 | 100 | 100 | 100 | 100 | 100 |  |  | 600 | 0 | 3 |
| CA\_n258L | CA\_n258G  CA\_n258H  CA\_n258I  CA\_n258J  CA\_n258K  CA\_n258L | 50, 100 | 100 | 100 | 100 | 100 | 100 | 100 |  | 700 | 0 |  |
| CA\_n258M | CA\_n258G  CA\_n258H  CA\_n258I  CA\_n258J  CA\_n258K  CA\_n258L  CA\_n258M | 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\_n260E | CA\_n260E | 50, 100, 200 | 200 | 200 |  |  |  |  |  | 600 | 0 |
| CA\_n260F | CA\_n260F | 50, 100, 200 | 200 | 200 | 200 |  |  |  |  | 800 | 0 |
| CA\_n260G | CA\_n260G | 50, 100 | 100 |  |  |  |  |  |  | 200 | 0 | 3 |
| 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 |
| 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\_n261B | CA\_n261B | 50, 100, 200, 400 | 400 |  |  |  |  |  |  | 800 | 0 | 1 |
| CA\_n261C | CA\_n261B | 50 | 400 | 400 |  |  |  |  |  | 8501 | 0 |
| CA\_n261D | CA\_n261D | 50, 100, 200 | 200 |  |  |  |  |  |  | 400 | 0 | 2 |
| CA\_n261E | CA\_n261E | 50, 100, 200 | 200 | 200 |  |  |  |  |  | 600 | 0 |
| CA\_n261F | CA\_n261F | 50, 100, 200 | 200 | 200 | 200 |  |  |  |  | 800 | 0 |
| CA\_n261G | CA\_n261G | 50, 100 | 100 |  |  |  |  |  |  | 200 | 0 | 3 |
| CA\_n261H | CA\_n261H | 50, 100 | 100 | 100 |  |  |  |  |  | 300 | 0 |
| CA\_n261I | CA\_n261I | 50, 100 | 100 | 100 | 100 |  |  |  |  | 400 | 0 |
| 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 |
| 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 | (BWChannel,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: (BWChannel,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 | (BWChannel,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-P) | CA\_n260D CA\_n260P | CA\_n260D | CA\_n260P |  |  |  |  |  | 700 | 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(G-I) | CA\_n260G CA\_n260I | CA\_n260G | CA\_n260I |  |  |  |  |  | 600 | 0 |
|
| CA\_n261(D-G) | CA\_n261D CA\_n261G | CA\_n261D | CA\_n261G |  |  |  |  |  | 600 | 0 |
|
| CA\_n261(D-H) | CA\_n261D CA\_n261H | CA\_n261D | CA\_n261H |  |  |  |  |  | 700 | 0 |
|
| CA\_n261(D-I) | CA\_n261D CA\_n261I | CA\_n261D | CA\_n261I |  |  |  |  |  | 800 | 0 |
|
| CA\_n261(D-O) | CA\_n261D CA\_n261O | CA\_n261D | CA\_n261O |  |  |  |  |  | 600 | 0 |
|
| CA\_n261(D-P) | CA\_n261D CA\_n261P | CA\_n261D | CA\_n261P |  |  |  |  |  | 700 | 0 |
|
| CA\_n261(D-Q) | CA\_n261D CA\_n261Q | CA\_n261D | CA\_n261Q |  |  |  |  |  | 800 | 0 |
|
| CA\_n261(E-O) | CA\_n261E CA\_n261O | CA\_n261E | CA\_n261O |  |  |  |  |  | 800 | 0 |
|
| CA\_n261(E-P) | CA\_n261E CA\_n261P | CA\_n261E | CA\_n261P |  |  |  |  |  | 800 | 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: (BWChannel,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.