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(3GPP TS 38.101-2 version 15.29.0 Release 15)**



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# Foreword

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

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

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# 1 Scope

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

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# 2 References

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

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

- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] 3GPP TS 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone"
- [3] 3GPP TS 38.101-3: "NR; User Equipment (UE) radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios"
- [4] Void
- [5] 3GPP TS 38.521-2: "NR; User Equipment (UE) conformance specification; Radio transmission and reception; Part 2: Range 2 Standalone"
- [6] Recommendation ITU-R M.1545: "Measurement uncertainty as it applies to test limits for the terrestrial component of International Mobile Telecommunications-2000"
- [7] ITU-R Recommendation SM.329-10, "Unwanted emissions in the spurious domain"
- [8] 47 CFR Part 30, "UPPER MICROWAVE FLEXIBLE USE SERVICE, §30.202 Power limits", FCC.
- [9] 3GPP TS 38.211: "NR; Physical channels and modulation".
- [10] 3GPP TS 38.213: "NR; Physical layer procedures for control".
- [11] 3GPP TS 38.215: "NR; Physical layer measurements".
- [12] 3GPP TS 38.133: "NR; Requirements for support of radio resource management".
- [13] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification".
- [14] 3GPP TS 38.306: "NR; User Equipment (UE) radio access capabilities".
- [15] IEEE Std 149: "IEEE Standard Test Procedures for Antennas", IEEE.

## 3 Definitions, symbols and abbreviations

### 3.1 Definitions

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

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

**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=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=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=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 Tx 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

**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.

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=Spherical coverage grid, Meas=Link angle):** measurement of the EIS spherical coverage of the UE such that the EIS 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 Rx beam peak search grid as the results from the Rx beam peak search can be re-used for spherical coverage.

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

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

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

**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 J. 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 J

**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.

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

**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

**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 $\Delta EIRP_{BC} = EIRP_2 - EIRP_1$
$\Delta F_{Global}$	Granularity of the global frequency raster
$\Delta F_{Raster}$	Band dependent channel raster granularity
$\Delta f_{OOB}$	$\Delta$ Frequency of Out Of Band emission
$\Delta_{RB}$	The starting frequency offset between the allocated RB and the measured non-allocated RB
$\Delta R_{IB}$	Allowed reference sensitivity relaxation due to support for inter-band CA operation
$\Delta R_{IBC}$	Allowed reference sensitivity relaxation due to support for intra-band contiguous CA operation
$\Delta R_{IBNC}$	Allowed reference sensitivity relaxation due to support for intra-band non-contiguous CA operation
$\Delta MB_{P,n}$	Allowed relaxation to minimum peak EIRP and reference sensitivity due to support for multi-band operation, per supported band in a combination.
$\Delta MB_{S,n}$	Allowed relaxation to EIRP spherical coverage and EIS spherical coverage due to support for multi-band operation, per supported band in a combination
$\sum MB_P$	Total allowed relaxation to minimum peak EIRP and reference sensitivity due to support for multi-band operation, for all supported bands in a combination
$\sum MB_S$	Total allowed relaxation to each, EIRP spherical coverage and EIS spherical coverage due to support for multi-band operation, for all supported bands in a combination

$BW_{\text{Channel}}$	Channel bandwidth
$BW_{\text{Channel\_CA}}$	Aggregated channel bandwidth, expressed in MHz
$BW_{\text{GB}}$	$\max(BW_{\text{GB,Channel}(k)})$
$BW_{\text{GB,Channel}(k)}$	Minimum guard band defined in clause 5.3A.2 of carrier $k$
$BW_{\text{interferer}}$	Bandwidth of the interferer
$BW_{\text{intraCA}}$	Aggregated channel bandwidth for intra-band contiguous CA with or without contiguous RBs allocation and intra-band non-contiguous CA, expressed in MHz. $BW_{\text{intraCA}} = BW_{\text{Channel\_CA}}$ in case of contiguous RBs allocation. $BW_{\text{intraCA}}$ is the frequency separation between the lower edge of the lowest allocated RB and the higher edge of the highest allocated RB in case of non-contiguous RBs allocation and intra-band non-contiguous CA.
$\text{Ceil}(x)$	Rounding upwards; $\text{ceil}(x)$ is the smallest integer such that $\text{ceil}(x) \geq x$
$\text{EIRP}_1$	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
$\text{EIRP}_2$	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
$\text{EIRP}_{\text{max}}$	The applicable maximum EIRP as specified in clause 6.2.1
$\text{Floor}(x)$	Rounding downwards; $\text{floor}(x)$ is the greatest integer such that $\text{floor}(x) \leq x$
$F_{\text{center}}$	The center frequency of an allocated block of PRBs
$F_{\text{C}}$	Center frequency of a carrier for a numerology defined by the <i>RF reference frequency</i> on the channel raster mapped to the carrier according to sub-clause 5.4.2.2
$F_{\text{C,block,high}}$	$F_{\text{C}}$ of the highest transmitted/received carrier in a sub-block.
$F_{\text{C,block,low}}$	$F_{\text{C}}$ of the lowest transmitted/received carrier in a sub-block.
$F_{\text{C,low}}$	The $F_{\text{C}}$ of the lowest carrier, expressed in MHz.
$F_{\text{C,high}}$	The $F_{\text{C}}$ of the highest carrier, expressed in MHz.
$F_{\text{DL,low}}$	The lowest frequency of the downlink <i>operating band</i>
$F_{\text{DL,high}}$	The highest frequency of the downlink <i>operating band</i>
$F_{\text{edge,block,low}}$	The lower sub-block edge, where $F_{\text{edge,block,low}} = F_{\text{C,block,low}} - F_{\text{offset,low}}$ .
$F_{\text{edge,block,high}}$	The upper sub-block edge, where $F_{\text{edge,block,high}} = F_{\text{C,block,high}} + F_{\text{offset,high}}$ .
$F_{\text{edge,low}}$	The lower edge of <i>Aggregated Channel Bandwidth</i> , expressed in MHz. $F_{\text{edge,low}} = F_{\text{C,low}} - F_{\text{offset,low}}$ .
$F_{\text{edge,high}}$	The upper edge of <i>Aggregated Channel Bandwidth</i> , expressed in MHz. $F_{\text{edge,high}} = F_{\text{C,high}} + F_{\text{offset,high}}$ .
$F_{\text{interferer}}$	Frequency of the interferer
$F_{\text{interferer (offset)}}$	Frequency offset of the interferer (between the center frequency of the interferer and the carrier frequency of the carrier measured)
$F_{\text{offset}}$	Frequency offset of the interferer (between the center frequency of the interferer and the closest edge of the carrier measured)
$\text{Floor}(x)$	Rounding downwards; $\text{floor}(x)$ is the greatest integer such that $\text{floor}(x) \leq x$
$F_{\text{offset,low}}$	Frequency offset from $F_{\text{C,low}}$ to the lower <i>UE RF Bandwidth edge</i> , or from $F_{\text{C,block,low}}$ to the lower sub-block edge
$F_{\text{offset,high}}$	Frequency offset from $F_{\text{C,high}}$ to the upper <i>UE RF Bandwidth edge</i> , or from $F_{\text{C,block,high}}$ to the upper sub-block edge
$F_{\text{OOB}}$	The boundary between the NR out of band emission and spurious emission domains
$F_{\text{REF}}$	RF reference frequency
$F_{\text{REF-Offs}}$	Offset used for calculating $F_{\text{REF}}$
$F_{\text{UL,low}}$	The lowest frequency of the uplink <i>operating band</i>
$F_{\text{UL,high}}$	The highest frequency of the uplink <i>operating band</i>
$F_{\text{UL,Meas}}$	The sub-carrier frequency for which the equalizer coefficient is evaluated
$\text{GB}_{\text{Channel}}$	Minimum guard band defined in clause 5.3.3, expressed in kHz
$L_{\text{CRB}}$	Transmission bandwidth which represents the length of a contiguous resource block allocation expressed in units of resources blocks
$L_{\text{CRB,Max}}$	Maximum number of RB for a given Channel bandwidth and sub-carrier spacing
$\text{Max}()$	The largest of given numbers
$\text{Min}()$	The smallest of given numbers
$\text{MPR}_{f,c}$	Maximum output power reduction for carrier $f$ of serving cell $c$
$\text{MPR}_{\text{narrow}}$	Maximum output power reduction due to narrow PRB allocation
$\text{MPR}_{\text{WT}}$	Maximum power reduction due to modulation orders, transmit bandwidth configurations, waveform types
$n_{\text{PRB}}$	Physical resource block number
$\text{NR}_{\text{ACLR}}$	NR ACLR
$\text{NR}_{\text{RB}}$	Transmission bandwidth configuration, expressed in units of resource blocks