**3GPP TSG-RAN WG4 Meeting #116 *R4-2512699***

**Bangaluru, India, 25th – 29th August, 2025**

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| *CR-Form-v12.3* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **38.104** | **CR** | **0736** | **rev** | **1** | **Current version:** | **19.1.0** |  |
|  | | | | | | | | |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network | **X** | Core Network |  |

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| ***Title:*** | Big CR to 38.104 on LPWUS | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Huawei, HiSilicon, vivo, Nokia, ZTE, CATT, Qualcomm, Ericsson, CMCC | | | | | | | | | |
| ***Source to TSG:*** | R4 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_LPWUS-Core | | | | |  | ***Date:*** | | | 2025-08-29 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | | Rel-19 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)  Rel-20 (Release 20)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | To introduce all BS RF requirements for LP-WUS operation. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | LP-WUS definition, applicable bands and other BS RF requirements for LP-WUS operation are added in the specification. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | LP-WUS operation cannot be supported. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 3.3, 5.2, 6.5.2.1, 6.6.2.2, 6.6.3.1, 6.6.4.1, 6.6.5.1, 6.7.2.1, 9.6.2.1, 9.7.2.2, 9.7.3.1, 9.7.4.1, 9.7.5.1 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **X** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | | **X** |  | Test specifications | | | | TS 38.141-1, TS 38.141-2 | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | | Revised from R4-2512600 | | | | | | | | |

## **<<Start of change>>**

## 3.3 Abbreviations

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

AA Antenna Array

AAS Active Antenna System

ACLR Adjacent Channel Leakage Ratio

ACS Adjacent Channel Selectivity

AoA Angle of Arrival

ATG Air-To-Ground

AWGN Additive White Gaussian Noise

BS Base Station

BW Bandwidth

CA Carrier Aggregation

CACLR Cumulative ACLR

CPE Common Phase Error

CP-OFDM Cyclic Prefix-OFDM

CW Continuous Wave

DFT-s-OFDM Discrete Fourier Transform-spread-OFDM

DM-RS Demodulation Reference Signal

EIS Equivalent Isotropic Sensitivity

EIRP Effective Isotropic Radiated Power

EEIRP Expected EIRP

E-UTRA Evolved UTRA

EVM Error Vector Magnitude

FBW Fractional Bandwidth

FR Frequency Range

FRC Fixed Reference Channel

FSS Fixed Satellite Service

FRMCS Future Railway Mobile Communication System

GSCN Global Synchronization Channel Number

GSM Global System for Mobile communications

HAPS High Altitude Platform Station

ITU‑R Radiocommunication Sector of the International Telecommunication Union

ICS In-Channel Selectivity

LA Local Area

LNA Low Noise Amplifier

LP-WUS Low-Power Wake-Up Signal

MCS Modulation and Coding Scheme

MR Medium Range

NB-IoT Narrowband – Internet of Things

NR New Radio

NR-ARFCN NR Absolute Radio Frequency Channel Number

OBUE Operating Band Unwanted Emissions

OCC Orthogonal Covering Code

OOB Out-of-band

OSDD OTA Sensitivity Directions Declaration

OTA Over-The-Air

PRB Physical Resource Block

PT-RS Phase Tracking Reference Signal

QAM Quadrature Amplitude Modulation

RB Resource Block

RDN Radio Distribution Network

RE Resource Element

REFSENS Reference Sensitivity

RF Radio Frequency

RIB Radiated Interface Boundary

RMR Railway Mobile Radio

RMS Root Mean Square (value)

RoAoA Range of Angles of Arrival

QAM Quadrature Amplitude Modulation

RB Resource Block

RX Receiver

SCS Sub-Carrier Spacing

SDL Supplementary Downlink

SS Synchronization Symbol

SSB Synchronization Signal Block

SUL Supplementary Uplink

TAB Transceiver Array Boundary

TAE Time Alignment Error

TDL Tapped Delay Line

TX Transmitter

TRP Total Radiated Power

UCI Uplink Control Information

UEM Unwanted Emissions Mask

UTRA Universal Terrestrial Radio Access

WA Wide Area

ZF Zero Forcing

## **<<Next change>>**

## 5.2 *Operating bands*

NR is designed to operate in the *operating bands* defined in table 5.2-1 and 5.2-2.

NR operating band n1, n2, n3, n5, n7, n8, n20, n25, n26, n28, n34, n38, n39, n41, n67, n85 and n90 which are defined in Table 5.2-1, can be applied for HAPS operation.

NOTE: For HAPS operation, the UL and DL frequency ranges are identifed in Nos. 5.312B, 5.314A, 5.388A and 5.409A and under the conditions specified in Resolutions 213, 218 and 221 in the ITU Radio Regulations [28].

NR operating bands n1, n3, n34, n39, n41, n78, n79, which are defined in Table 5.2-1, can be applied for ATG operation.

NB-IoT is designed to operate in the NR operating bands n1, n2, n3, n5, n7, n8, n12, n13, n14, n18, n20, n25, n26, n28, n31, n41, n65, n66, n70, n71, n72, n74, n85, n87, n88, n90, n106 which are defined in Table 5.2-1.

LP-WUS is designed to operate in the NR operating bands defined in Table 5.2-1 for FR1 and Table 5.2-2 for FR2-1, excluding SUL and SDL bands as well as bands n46, n47, n96, and n102.

## **<<Next change>>**

### 6.5.2 Modulation quality

#### 6.5.2.1 General

Modulation quality is defined by the difference between the measured carrier signal and an ideal signal. Modulation quality can e.g. be expressed as Error Vector Magnitude (EVM). The Error Vector Magnitude is a measure of the difference between the ideal symbols and the measured symbols after the equalization. This difference is called the error vector. Details about how the EVM is determined are specified in Annex B.

For *BS type 1-C* this requirement shall be applied at the *antenna connector* supporting transmission in the *operating band*.

For *BS type 1-H* this requirement shall be applied at each *TAB connector* supporting transmission in the *operating band.*

NOTE: LP-WUS signal transmitting signal quality is assured in NR BS with NR signal transmission.

## **<<Next change>>**

6.6.2.2 Minimum requirement for *BS type 1-C* and *BS type 1-H*

The occupied bandwidth for each NR carrier shall be less than the *BS channel bandwidth*. For intra-band contiguous CA, the occupied bandwidth shall be less than or equal the *Aggregated BS Channel Bandwidth*.

For NB.IoT operation in NR in-band, the occupied bandwidth for each NR carrier with NB-IoT shall be less than than the *BS channel bandwidth*.

If the BS supports LP-WUS operation, the occupied bandwidth for each NR carrier with LP-WUS shall be less than the *BS channel bandwidth*.

## **<<Next change>>**

6.6.3.1 General

Adjacent Channel Leakage power Ratio (ACLR) is the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency.

The requirements shall apply outside the *Base Station RF Bandwidth* or *Radio Bandwidth* whatever the type of transmitter considered (single carrier or multi-carrier) and for all transmission modes foreseen by the manufacturer’s specification.

The requirements shall also apply if the BS supports NB-IoT operation in NR in-band.

The requirements shall also apply if the BS supports LP-WUS operation.

For a BS operating in *non-contiguous spectrum*, the ACLR or the CACLR requirement in Tables 6.6.3.2-2a to 6.6.3.2-3aa shall apply in *sub-block gaps*, depending on the *operating band* and the *sub-block* *gap size* (Wgap) where the limit applies.

For a *multi-band connector*, the ACLR or the CACLR requirement in Tables 6.6.3.2-2a to 6.6.3.2-3aa shall apply in *Inter RF Bandwidth gaps*, depending on the *operating band* and the *Inter RF Bandwidth gap size* (Wgap) where the limit applies.

The requirement shall apply during the *transmitter ON period*.

## **<<Next change>>**

6.6.4.1 General

Unless otherwise stated, the operating band unwanted emission (OBUE) limits in FR1 are defined from ΔfOBUE below the lowest frequency of each supported downlink *operating band* up to ΔfOBUE above the highest frequency of each supported downlink *operating band*. The values of ΔfOBUE are defined in table 6.6.1‑1 for the NR *operating bands*.

The requirements shall apply whatever the type of transmitter considered and for all transmission modes foreseen by the manufacturer’s specification. In addition, for a BS operating in *non-contiguous spectrum*, the requirements apply inside any *sub-block gap*. In addition, for a BS operating in multiple bands, the requirements apply inside any *Inter RF Bandwidth gap*.

*Basic limits* are specified in the tables below, where:

- Δf is the separation between the *channel edge* frequency and the nominal -3dB point of the measuring filter closest to the carrier frequency.

- f\_offset is the separation between the *channel edge* frequency and the centre of the measuring filter.

- f\_offsetmax is the offset to the frequency ΔfOBUE outside the downlink *operating band*, where ΔfOBUE is defined in table 6.6.1-1.

- Δfmax is equal to f\_offsetmax minus half of the bandwidth of the measuring filter.

For a *multi-band connector* inside any *Inter RF Bandwidth gaps* with Wgap < 2\*ΔfOBUE, a combined *basic* limit shall be applied which is the cumulative sum of the *basic limit*s specified at the *Base Station RF Bandwidth edges* on each side of the *Inter RF Bandwidth gap*. The *basic limit* for *Base Station RF Bandwidth edge* is specified in clauses 6.6.4.2.1 to 6.6.4.2.4 below, where in this case:

- Δf is the separation between the *Base Station RF Bandwidth edge* frequency and the nominal -3 dB point of the measuring filter closest to the *Base Station RF Bandwidth edge*.

- f\_offset is the separation between the *Base Station RF Bandwidth edge* frequency and the centre of the measuring filter.

- f\_offsetmax is equal to the *Inter RF Bandwidth gap* minus half of the bandwidth of the measuring filter.

- Δfmax is equal to f\_offsetmax minus half of the bandwidth of the measuring filter.

For a multi-carrier *single-band connector* or a *single-band connector* configured for intra-band contiguous or non-contiguous *carrier aggregation* the definitions above apply to the lower edge of the carrier transmitted at the *lowest carrier* frequency and the upper edge of the carrier transmitted at the *highest carrier* frequency within a specified frequency band.

- In case the *inter-band gap* between a supported downlink *operating band* with carrier(s) transmitted and a supported downlink *operating band* without any carrier transmitted is less than 2\*ΔfOBUE, f\_offsetmax shall be the offset to the frequency ΔfOBUE MHz outside the outermost edges of the two supported downlink *operating bands* and the operating band unwanted emission *basic limits* of the band where there are carriers transmitted, as defined in the tables of the present clause, shall apply across both downlink bands.

- In other cases, the operating band unwanted emission *basic limits* of the band where there are carriers transmitted, as defined in the tables of the present clause for the largest frequency offset (Δfmax), shall apply from ΔfOBUE MHz below the lowest frequency, up to ΔfOBUE MHz above the highest frequency of the supported downlink *operating band* without any carrier transmitted.

For a multicarrier *single-band connector* or a *single-band connector* configured for intra-band contiguous or non-contiguous *carrier aggregation* the definitions above apply to the lower edge of the carrier transmitted at the *lowest carrier* frequency and the upper edge of the carrier transmitted at the *highest carrier* frequency within a specified frequency band.

In addition, inside any *sub-block gap* for a *single-band connector* operating in *non-contiguous spectrum*, a combined *basic* limit shall be applied which is the cumulative sum of the *basic limit*s specified for the adjacent *sub-blocks* on each side of the *sub-block gap*. The *basic limit* for each *sub-block* is specified in clauses 6.6.4.2.1 to 6.6.4.2.4 below, where in this case:

- Δf is the separation between the *sub-block* edge frequency and the nominal -3 dB point of the measuring filter closest to the *sub-block* edge.

- f\_offset is the separation between the *sub-block* edge frequency and the centre of the measuring filter.

- f\_offsetmax is equal to the *sub-block gap* bandwidth minus half of the bandwidth of the measuring filter.

- Δfmax is equal to f\_offsetmax minus half of the bandwidth of the measuring filter.

For Wide Area BS, the requirements of either clause 6.6.4.2.1 (Category A limits) or clause 6.6.4.2.2 (Category B limits) shall apply.

For Medium Range BS, the requirements in clause 6.6.4.2.3 shall apply (Category A and B).

For Local Area BS, the requirements of clause 6.6.4.2.4 shall apply (Category A and B).

The requirements shall also apply if the BS supports NB-IoT operation in NR in-band.

The requirements shall also apply if the BS supports LP-WUS operation.

The application of either Category A or Category B *basic limits* shall be the same as for Transmitter spurious emissions in clause 6.6.5.

## **<<Next change>>**

6.6.5.1 General

The transmitter spurious emission limits shall apply from 9 kHz to 12.75 GHz, excluding the frequency range from ΔfOBUE below the lowest frequency of each supported downlink *operating band*, up to ΔfOBUE above the highest frequency of each supported downlink *operating band*, where the ΔfOBUE is defined in table 6.6.1-1. For some *operating bands*, the upper limit is higher than 12.75 GHz in order to comply with the 5th harmonic limit of the downlink *operating band*, as specified in ITU-R recommendation SM.329 [2].

For a *multi-band connector*, for each supported *operating band* together with ΔfOBUE around the band is excluded from the transmitter spurious emissions requirement.

The requirements shall apply whatever the type of transmitter considered (single carrier or multi-carrier). It applies for all transmission modes foreseen by the manufacturer's specification.

The requirements shall also apply if the BS supports NB-IoT operation in NR in-band.

The requirements shall also apply if the BS supports LP-WUS operation.

Unless otherwise stated, all requirements are measured as mean power (RMS).

## **<<Next change>>**

6.7.2.1 Co-location minimum requirements

For *BS type 1-C*, the wanted signal and interfering signal centre frequency is specified in table 6.7.2.1‑1, where interfering signal level is *Rated total output power* (Prated,t,AC) at *antenna connector* in the *operating band* – 30 dB.

The requirement is applicable outside the *Base Station RF Bandwidth* or *Radio Bandwidth*. The interfering signal offset is defined relative to the *Base Station RF Bandwidth edges* or *Radio Bandwidth* edges.

For a BS operating in *non-contiguous spectrum*, the requirement is also applicable inside a *sub-block gap* for interfering signal offsets where the interfering signal falls completely within the *sub-block gap*. The interfering signal offset is defined relative to the *sub-block* edges.

For a *multi-band connector*, the requirement shall apply relative to the *Base Station RF Bandwidth edges* of each supported *operating band*. In case the *Inter RF Bandwidth gap* is less than 3\*BWChannel (where BWChannel is the minimal *BS channel bandwidth* of the band), the requirement in the gap shall apply only for interfering signal offsets where the interfering signal falls completely within the *Inter RF Bandwidth gap*.

The transmitter intermodulation level shall not exceed the unwanted emission limits in clauses 6.6.3, 6.6.4 and 6.6.5 in the presence of an NR interfering signal according to table 6.7.2.1-1.

The requirements shall also apply if the BS supports LP-WUS operation.

**Table 6.7.2.1-1: Interfering and wanted signals for the co-location transmitter intermodulation requirement**

| **Parameter** | **Value** |
| --- | --- |
| Wanted signal type | NR single carrier, or multi-carrier, or multiple intra-band contiguously or non-contiguously aggregated carriers, with NB-IoT operation in NR in-band if supported. |
| Interfering signal type | NR signal, the minimum *BS channel bandwidth* (BWChannel) with 15 kHz SCS of the band defined in clause 5.3.5. |
| Interfering signal level | *Rated total output power* (Prated,t,AC) in the *operating band* – 30 dB |
| Interfering signal centre frequency offset from the lower/upper edge of the wanted signal or edge of *sub-block* inside a *sub-block gap* | , for n=1, 2 and 3 |
| NOTE 1: Interfering signal positions that are partially or completely outside of any downlink *operating band* of the base station are excluded from the requirement, unless the interfering signal positions fall within the frequency range of adjacent downlink *operating bands* in the same geographical area. In case that none of the interfering signal positions fall completely within the frequency range of the downlink *operating band*, TS 38.141-1 [5] provides further guidance regarding appropriate test requirements.  NOTE 2: In Japan, NOTE 1 is not applied in Band n77, n78, n79. | |

## **<<Next change>>**

#### 9.6.2.1 General

Modulation quality is defined by the difference between the measured carrier signal and an ideal signal. Modulation quality can e.g. be expressed as Error Vector Magnitude (EVM). Details about how the EVM is determined are specified in Annex B for FR1 and Annex C for FR2.

OTA modulation quality requirement is defined as a *directional requirement* at the RIB and shall be met within the *OTA coverage range*.

NOTE: LP-WUS signal transmitting signal quality is assured in NR BS with NR signal transmission.

## **<<Next change>>**

#### 9.7.2.2 Minimum requirement for *BS type 1-O* and *BS type* 2-O

The OTA occupied bandwidth for each NR carrier shall be less than the *BS channel bandwidth*. For intra-band contiguous CA, the OTA occupied bandwidth shall be less than or equal to the *Aggregated BS Channel Bandwidth*.

If the BS supports LP-WUS operation, the occupied bandwidth for each NR carrier with LP-WUS shall be less than the *BS channel bandwidth*.

## **<<Next change>>**

#### 9.7.3.1 General

OTA Adjacent Channel Leakage power Ratio (ACLR) is the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency. The measured power is TRP.

The requirement shall be applied per RIB during the *transmitter ON period*.

The requirements shall also apply if the BS supports LP-WUS operation.

## **<<Next change>>**

#### 9.7.4.1 General

The OTA limits for operating band unwanted emissions are specified as TRP per RIB unless otherwise stated.

The requirements shall also apply if the BS supports LP-WUS operation.

## **<<Next change>>**

#### 9.7.5.1 General

Unless otherwise stated, all requirements are measured as mean power.

The OTA spurious emissions limits are specified as TRP per RIB unless otherwise stated.

The requirements shall also apply if the BS supports LP-WUS operation.

## **<<End of change>>**