ETSI TS 138 194 V19.1.0 (2026-02)

TECHNICAL SPECIFICATION

5G;
NR;
Ambient IoT Base Station (BS) and Carrier-Wave (CW) node radio transmission and reception
(3GPP TS 38.194 version 19.1.0 Release 19)

Reference
RTS/TSGR-0438194vj10

Keywords
5G

ETSI

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Contents

Foreword

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

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- 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.

In the present document, modal verbs have the following meanings:

shall indicates a mandatory requirement to do something

shall not indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

should indicates a recommendation to do something

should not indicates a recommendation not to do something

may indicates permission to do something

need not indicates permission not to do something

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will indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

will not indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

might indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

might not indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

is (or any other verb in the indicative mood) indicates a statement of fact

is not (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

1 Scope

The present document establishes the minimum RF characteristics and minimum performance requirements of Ambient IoT Base Station (A-IoT BS) and Carrier-Wave (CW) node.

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] ITU-R Recommendation SM.329: "Unwanted emissions in the spurious domain".

[3] 3GPP TS 38.195: "Ambient IoT Base Station (BS) and Carrier-Wave (CW) node conformance testing".

[4] Recommendation ITU-R M.1545: "Measurement uncertainty as it applies to test limits for the terrestrial component of International Mobile Telecommunications-2000".

[5] 3GPP TS 38.211: "Physical channels and modulation".

[6] 3GPP TS 38.104: "NR; Base Station (BS) radio transmission and reception ".

[7] 3GPP TS 38.291: "NR; Ambient IoT Physical layer".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms 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].

antenna connector: connector at the conducted interface of the *BS type 1-C*

active transmitter unit: transmitter unit which is ON, and has the ability to send modulated data streams that are parallel and distinct to those sent from other transmitter units to a *BS type 1-C antenna connector*

Base Station RF Bandwidth: RF bandwidth in which a base station transmits and/or receives single or multiple carrier(s) within a supported *operating band*

NOTE: In single carrier operation, the *Base Station RF Bandwidth* is equal to the *BS channel bandwidth*.

Base Station RF Bandwidth edge: frequency of one of the edges of the *Base Station RF Bandwidth*.

basic limit: emissions limit relating to the power supplied by a single transmitter to a single antenna transmission line in ITU-R SM.329 [2] used for the formulation of unwanted emission requirements for FR1

BS channel bandwidth: RF bandwidth supporting a single NR RF carrier with the *transmission bandwidth* configured in the uplink or downlink

NOTE 1: The *BS channel bandwidth* is measured in MHz and is used as a reference for transmitter and receiver RF requirements.

NOTE 2: It is possible for the BS to transmit to and/or receive from one or more UE bandwidth parts that are smaller than or equal to the *BS transmission bandwidth configuration*, in any part of the *BS transmission bandwidth configuration*.

BS transmission bandwidth: set of resource blocks located within the *BS channel bandwidth* which may be used for transmitting by the BS

BS type 1-C: NR base station operating at FR1 with requirements set consisting only of conducted requirements defined at individual *antenna connectors*

maximum carrier output power: mean power level measured per carrier at the indicated interface, during the *transmitter ON period* in a specified reference condition

maximum total output power: mean power level measured within the *operating band* at the indicated interface, during the *transmitter ON period* in a specified reference condition

measurement bandwidth: RF bandwidth in which an emission level is specified

operating band: frequency range in which NR operates (paired or unpaired), that is defined with a specific set of technical requirements

NOTE: The *operating band*(s) for a BS is declared by the manufacturer according to the designations in tables 5.2-1.

rated carrier output power: mean power level associated with a particular carrier the manufacturer has declared to be available at the indicated interface, during the *transmitter ON period* in a specified reference condition

transmission bandwidth: RF Bandwidth of an instantaneous transmission from a UE or BS, measured in resource block units

transmitter OFF period: time period during which the BS transmitter is not allowed to transmit

transmitter ON period: time period during which the BS transmitter is transmitting data and/or reference symbols

transmitter transient period: time period during which the transmitter is changing from the OFF period to the ON period or vice versa

3.2 Symbols

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

$BW_{Channel}$	*BS channel bandwidth*
BW_{Config}	*Transmission bandwidth*, where $BW_{Config} = N_{RB}$ x SCS x 12
Δf	Separation between the *channel edge* frequency and the nominal -3 dB point of the measuring filter closest to the carrier frequency
Δf_{BE_offset}	Separation between the edge of the last transmitted channel of the channels assigned for NR-U channel bandwidth and the nominal -3 dB point of the measuring filter closest to the carrier frequency
ΔF_{Global}	Global frequency raster granularity
Δf_{max}	f_offset_{max} minus half of the bandwidth of the measuring filter
Δf_{OBUE}	Maximum offset of the *operating band* unwanted emissions mask from the downlink *operating band* edge
Δf_{OOB}	Maximum offset of the out-of-band boundary from the uplink *operating band* edge
ΔF_{Raster}	Channel raster granularity
F_C	*RF reference frequency* on the channel raster, given in table 5.4.2.2-1
F_{filter}	Filter centre frequency
f_offset	Separation between the *channel edge* frequency and the centre of the measuring
f_offset_{max}	The offset to the frequency Δf_{OBUE} outside the downlink *operating band*
F_{REF}	RF reference frequency
$F_{REF-Offs}$	Offset used for calculating F_{REF}
N_{RB}	*Transmission bandwidth configuration*, expressed in resource blocks

N_{REF}	A-IoT Absolute Radio Frequency Channel Number (AIoT-ARFCN)
$N_{REF-Offs}$	Offset used for calculating N_{REF}
$P_{max,c,AC}$	*Maximum carrier output power* measured per *antenna connector*
$P_{rated,c,AC}$	The *rated carrier output power per antenna connector*
$P_{rated,t,AC}$	The *rated total output power* declared at the *antenna connector*
$P_{REFSENS}$	Conducted Reference Sensitivity power level

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].

2SB	Double sideband
ACLR	Adjacent Channel Leakage Ratio
ACS	Adjacent Channel Selectivity
AWGN	Additive White Gaussian Noise
A-IoT	Ambient IoT
A-IoT RAN	Ambient IoT Radio Access Network
BPSK	Binary phase-shift keying
BS	Base Station
BW	Bandwidth
CW	Carrier-wave
CW2D	Carrier-wave, or carrier-wave node, to device
D2R	Device to reader
FR	Frequency Range
FRC	Fixed Reference Channel
OOK	On-off keying
R2D	Reader to device
REFSENS	Reference Sensitivity
RF	Radio frequency
SCS	Sub-Carrier Spacing
SFO	Sampling-frequency offset
UEM	Unwanted Emissions Mask

4 General

4.1 Relationship between minimum requirements and test requirements

Conformance to the present specification is demonstrated by fulfilling the test requirements specified in the conformance specification TS 38.195[3].

The minimum requirements given in this specification make no allowance for measurement uncertainty. The test specifications TS 38.195 define test tolerances. These test tolerances are individually calculated for each test. The test tolerances are used to relax the minimum requirements in this specification to create test requirements. For some requirements, including regulatory requirements, the test tolerance is set to zero.

The measurement results returned by the test system are compared - without any modification - against the test requirements as defined by the shared risk principle.

The shared risk principle is defined in recommendation ITU-R M.1545. [4]

4.2 Regional requirements

Some requirements in the present document may only apply in certain regions either as optional requirements, or as mandatory requirements set by local and regional regulation. It is normally not stated in the 3GPP specifications under what exact circumstances the regional requirements apply, since this is defined by local or regional regulation.

5 Operating bands and channel arrangement

5.1 General

The channel arrangements presented in this clause are based on the *operating bands* and *BS channel bandwidths* defined in the present release of specifications.

NOTE: Other *operating bands* and *BS channel bandwidth*s 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 A-IoT can operate according to the present 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

5.2 Operating bands

A-IoT is designed to operate in the *operating bands* defined in table 5.2-1

Table 5.2-1: A-IoT *operating bands* in FR1

A-IoT *operating band*	Uplink (D2R&CW) *operating band* BS receive / UE transmit $F_{UL,low}$ – $F_{UL,high}$ (MHz)	Downlink (R2D) *operating band* BS transmit / UE receive $F_{DL,low}$ – $F_{DL,high}$ (MHz)	Duplex mode
n5	824 – 849	869 – 894	FDD
n8	880 – 915	925 – 960	FDD
n28	703 – 748	758 – 803	FDD

5.3 BS channel bandwidth

5.3.1 R2D Channel bandwidth

5.3.1.1 General

The *R2D channel bandwidth* supports a single reader RF carrier in R2D link at the reader.

The relationship between the R2D channel bandwidth, the guardband and the *transmission bandwidth* is shown in figure 5.3.1.1-1.

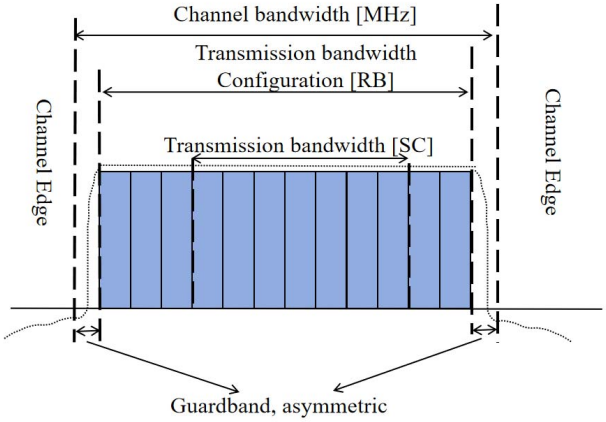

Figure 5.3.1.1-1: Definition of channel bandwidth and *transmission bandwidth configuration* for one reader channel

5.3.1.2 R2D Transmission bandwidth

The *transmission bandwidth* N_{RB} for each *reader channel bandwidth* and subcarrier spacing is specified in table 5.3.1.2-1.

Table 5.3.1.2-1: R2D Transmission bandwidth configuration N_{RB} for FR1

R2D Channel Bandwidth	200 kHz	400 kHz	600 kHz	800 kHz
SCS (kHz)	N_{RB}	N_{RB}	N_{RB}	N_{RB}
15	1	2	3	4

NOTE: All BS Tx and device Rx requirements are defined based on *transmission bandwidth configuration* specified in table 5.3.1.2-1.

5.3.1.3 Minimum guardband and R2D transmission bandwidth configuration

The minimum guardband for each *reader channel bandwidth* and SCS is specified in table 5.3.3-1.

Table 5.3.1.3-1: Minimum guardband (FR1)

R2D CBW	200 kHz	400 kHz	600 kHz	800 kHz
Minimum guardband (kHz)	2.5	12.5	22.5	32.5

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

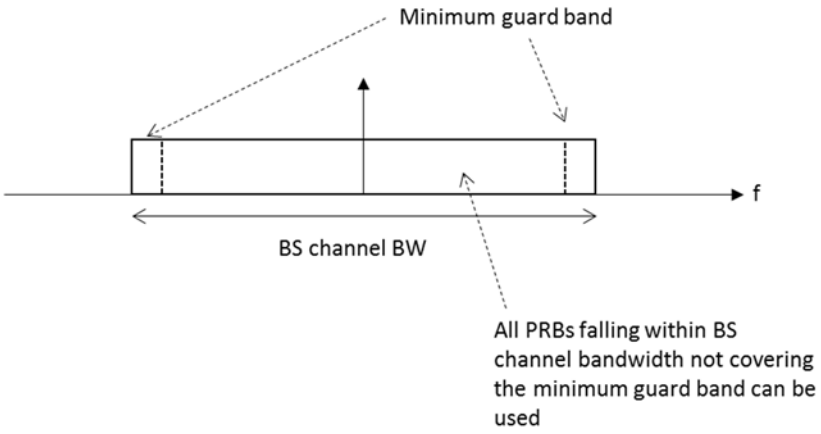

Figure 5.3.1.3-1: Reader PRB utilization

5.3.1.4 RB alignment

For each reader *channel bandwidth*, *BS transmission bandwidth configuration* must fulfil the minimum guardband requirement specified in clause 5.3.3.

5.3.1.5 R2D channel bandwidth per operating band

The requirements in this specification apply to the combination of *BS channel bandwidths*, SCS and *operating bands* shown in table 5.3.5-1 for FR1. The *transmission bandwidth configuration* in table 5.3.2-1 shall be supported for each of the *BS channel bandwidths* within the BS capability. The *BS channel bandwidths* are specified for the Tx path.

Table 5.3.5-1: BS channel bandwidths and SCS per operating band

A-IoT Bands	SCS (kHz)	*Reader channel bandwidth* (kHz)			
		200	400	600	800
n5, n8, n28	15	200	400	600	800

5.3.2 D2R Channel bandwidth

5.3.2.1 General

The D2R channel bandwidth supports a single NR RF carrier in the uplink at the BS. From a BS perspective, different device channel bandwidths may be supported within the same spectrum for transmitting to and backscattering from devices connected to the BS.

5.3.2.2 Minimum guardband

The minimum guardband for each D2R channel bandwidth at BS side is specified as 10% D2R channel bandwidth at BS side.

5.3.2.3 D2R channel bandwidth per operating band

The requirements in this specification only apply to the *operating band* n8 shown in in table 5.3.2.3-1 for BS.

Table 5.3.2.3-1: BS D2R channel bandwidth

BS D2R channel bandwidth (kHz)									
Nominal D2R transmission Bandwidth without SFO (kHz)	Norminal Small frequency shift without SFO(kHz)								
	3.75	7.5	15	30	60	120	240	480	720
15	19	28	46	83	156	303	596	1183	
30		37	55	92	165	312	605	1192	
60			74	110	184	330	624	1210	
120				147	220	367	660	1247	
240					294	440	734	1320	
480						587	880	1467	
960							1174	1760	
2880									3520

5.4 Channel arrangement

5.4.1 R2D Channel raster

5.4.1.1 NR-ARFCN and channel raster

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

RF reference frequencies are designated by an NR Absolute Radio Frequency Channel Number (NR-ARFCN) in the range [0…3279165] on the global frequency raster. The relation between the NR-ARFCN and the *RF reference frequency* F_{REF} in MHz is given by the following equation, where $F_{REF-Offs}$ and $N_{Ref-Offs}$ are given in table 5.4.1.1-1 and N_{REF} is the NR-ARFCN.

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

Table 5.4.1.1-1: NR-ARFCN parameters for the global frequency raster

Range of frequencies (MHz)	ΔF_{Global} (kHz)	$F_{REF-Offs}$ (MHz)	$N_{REF-Offs}$	Range of N_{REF}
0 – 3000	5	0	0	0 – 599999

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

The mapping between the *channel raster* and corresponding resource element is given in clause 5.4.1.2. The applicable entries for each *operating band* are defined in clause 5.4.1.3.

5.4.1.2 Channel raster to resource element mapping

The mapping between the *RF reference frequency* on the channel raster and the corresponding resource element is given in table 5.4.1.2-1 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 BS.

Table 5.4.1.2-1: Channel Raster to Resource Element Mapping

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

k, n_{PRB} and N_{RB} are as defined in TS 38.211 [5].

5.4.1.3 Channel raster entries for each *operating band*

The RF channel positions on the channel raster in each A-IoT operating band are given through the applicable NR-ARFCN in table 5.4.1.3-1, using the channel raster to resource element mapping in clause 5.4.1.2.

Channel raster is defined with $\Delta F_{Raster} = 2 \times \Delta F_{Global}$. In this case every 2th 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 5.4.1.3-1 is given as <2>.

Table 5.4.1.3-1: Applicable NR-ARFCN per operating band for enhanced channel raster

A-IoT **operating band**	**ΔF_{Raster} (kHz)**	**Uplink Range of N_{REF} (First – <Step size> – Last)**	**Downlink Range of N_{REF} (First – <Step size> – Last)**
n5	10	164800 – <2> – 169800	173800 – <2> – 178800
n8	10	176000 – <2> – 183000	185000 – <2> – 192000
n28	10	140600 – <2> – 149600	151600 – <2> – 160600
NOTE 1: The channel numbers that designate carrier frequencies so close to the operating band edges that the carrier extends beyond the operating band edge shall not be used. These channel numbers shall also be such that the minimum guard band for each channel bandwidth and SCS specified in Table 5.3.1.3 and 5.3.2.2 are met for carriers located at the upper or lower edge of an operating band.			

6 A-IoT BS transmitter characteristics

6.1 General

Unless otherwise stated, the conducted transmitter characteristics are specified at the antenna connector for BS type 1-C. A-IoT BS transmitter characteristics refer to that for BS type 1-C in clause 6 in TS38.104[6].

6.2 Base station output power

6.2.1 General

The A-IoT BS conducted output power requirement is at antenna connector for A-IoT BS type 1-C.

The rated carrier output power of the A-IoT BS type 1-C shall be less than or equal to 38dBm.

6.3 Transmit ON/OFF power

6.3.1 Transmitter OFF power

6.3.1.1 General

Transmitter OFF power for A-IoT BS is defined as the mean power measured over 70/N us filtered with a square filter of bandwidth equal to the transmission bandwidth configuration of the BS (BW_{Config}) centred on the assigned channel frequency during the *transmitter OFF period*. N = SCS/15, where SCS is Sub Carrier Spacing in kHz.

6.3.1.2 Minimum requirement for *A-IoT BS type 1-C*

For A-IoT BS type 1-C, the requirements for transmitter OFF power spectral density shall be less than -85 dBm/MHz per antenna connector.

6.3.2 Transmitter transient period

6.3.2.1 General

The transmitter transient period for A-IoT BS is the time period during which the transmitter is changing from the transmitter OFF period to the transmitter ON period or vice versa. The transmitter transient period is illustrated in figure 6.4.2.1-1.

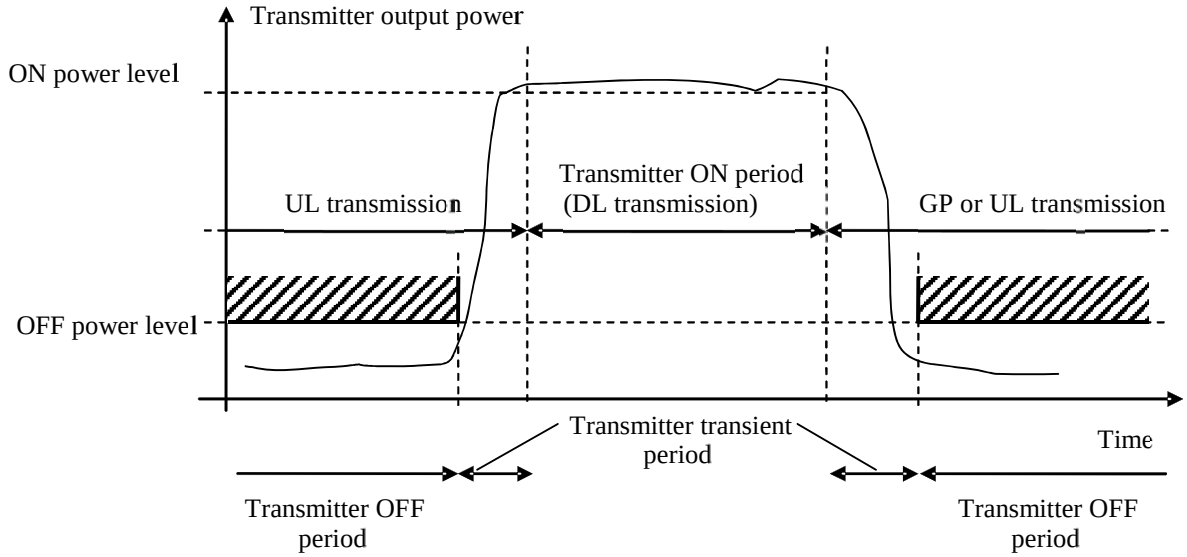

Figure 6.3.2.1-1: Example of relations between transmitter ON period, transmitter OFF period and *transmitter transient period*

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

6.3.2.2 Minimum requirement for *A-IoT BS type 1-C*

For A-IoT BS type 1-C, the transmitter transient period shall be shorter than the values listed in the minimum requirement table 6.3.2.2-1.

Table 6.3.2.2-1: Minimum requirement for the *transmitter transient period* for *A-IoT BS type 1-C*

Transition	Transient period length (μs)
OFF to ON	10
ON to OFF	10

6.4 Transmitted signal quality

6.4.1 Frequency error

6.4.1.1 General

The requirements in clause 6.4.1 apply to the transmitter ON period.

Frequency error is the measure of the difference between the actual BS transmit frequency and the assigned frequency. The same source shall be used for RF frequency and data clock generation.

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

6.4.1.2 Minimum requirement for *BS type 1-C*

For BS type 1-C, the modulated carrier frequency of each NR carrier configured by the BS shall be accurate to within the accuracy range given in table 6.4.1.2-1 observed over 1 ms.

Table 6.4.1.2-1: Frequency error minimum requirement

BS class	Accuracy
Medium Range BS	±0.1 ppm

6.4.2 Modulation quality

Based on TS38.291[7], R2D signal includes SIP (Start indicator part), CAP (Clock acquisition part), PRDCH, the R2D postamble and padding if needed.

An is measured peak high level for the n^{th} chip, in units of V/m or A/m

Bn is measured peak low level for the n^{th} chip, in units of V/m or A/m

Anavg is the measured average high level for the nth chip during1/2 duration above 90%An, in units of V/m or A/m

Bnavg is the measured average low level for the n^{th} chip during 1/2 duration below 10%An, in units of V/m or A/m

Modulation depth:

Modulation depth is defined with equation below and modulation depth for OOK chip 0/1 shall meet the requirements in Table 6.4.2-1.

Modulation depth =(Anavg-Bnavg)/Anavg

The envelope of electric filed strength for OOK chip 0 RF pulse shall comply the timing mask in Figure 6.4.2-1 and meet the requirements in Table 6.4.2-1. The envelope of electric filed strength for OOK Bit 0 shall decrease monotonically from 90% to less than 10 % of initial value Einitial during t1. The envelope of electric filed strength for OOK Bit 0 shall increase monotonically from 10% to less than 90 % of its initial value Einitial during t3. The initial value Einitial is defined as the field strength difference between Anavg and Bnavg.

RF Envelop Rise Time:

The $T_{r,10-90}$ measures the rise of the OOK bit 0 pulse and starts when envelop rises to 10% level of the initial value Einitial and ends when the envelop rises to 90% of the initial value Einitial.

RF Envelop Fall Time:

The $T_{f,10-90}$ measures the fall time of the OOK chip 0 pulse and starts when envelop falls to 90% level of the initial value Einitial and ends when the envelop falls to 10% of the initial value Einitial.

$T_{f,10-90}$ starts when the envelop drops to the 90% level of the initial value Einitial and ends when envelop rise to 10% level of the initial value Einitial.

Ripple:

Ripple_high (%) = ((An − Anavg) / (Anag-Bnavg)) × 100%

Ripple_low (%) = ((Bn − Bnavg) / (Anavg-Bnavg)) × 100%

In case of an overshoot or undershoot the field shall remain within +/- Ripple_high % of Einitial for OOK chip 1 and +/-Ripple_low % of Einitial for OOK chip 0.

Pulsewidth

The PW measures the time between envelop falling edge at 50% of the initial value Einitial and envelop rinsing edge at 50% of the initial value Einitial.

Table 6.4.2-1: A-IoT BS RF envelope parameters

R2D Chip duration: Tc	**Parameter**	**Symbol**	**Value**	**Units**
$Tc = \frac{10^3}{M * 15}(us)$ M {2,6,12,24}	Modulation Depth	(A–B)/A	80	%
	RF Envelope Ripple	Ripple_high Ripple_low	<=±15	%
	RF Envelop Rise Time	$T_{r,10-90}$	<=0.66Tc	µs
	RF Envelop Fall Time	$T_{f,10-90}$	<=0.66Tc	µs
	RF Pulsewidth	PW	<=1.3 Tc	µs

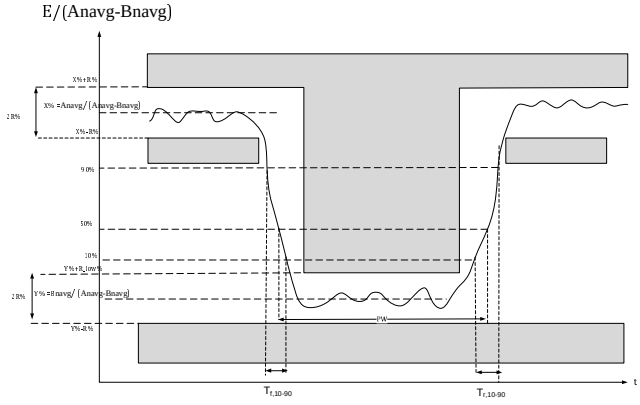

Figure 6.4.2-1: Timing mask for OOK chip 0 pulse

6.5 Unwanted emissions

6.5.1 General

Unwanted emissions consist of out-of-band emissions and spurious emissions according to ITU definitions [2]. In ITU terminology, out of band emissions are unwanted emissions immediately outside the BS R2D channel bandwidth resulting from the modulation process and non-linearity in the transmitter but excluding spurious emissions. Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emission, intermodulation products and frequency conversion products, but exclude out of band emissions.

The out-of-band emissions requirement for the BS transmitter is specified both in terms of Adjacent Channel Leakage power Ratio (ACLR) and *operating band* unwanted emissions (OBUE).

The maximum offset of the *operating band* unwanted emissions mask from the *operating band* edge is 10MHz. The Operating band unwanted emissions define all unwanted emissions in each supported downlink *operating band* plus the frequency ranges 10MHz above and 10MHz below each band. Unwanted emissions outside of this frequency range are limited by a spurious emissions requirement.

6.5.2 Occupied bandwidth

6.5.2.1 General

The occupied bandwidth requirement shall apply during transmitter ON period for a single transmitted carrier. The minimum requirement below may be applied regionally. There may also be regional requirements to declare the occupied bandwidth.

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

6.5.2.2 Minimum requirement for *BS type 1-C*

The occupied bandwidth for each NR carrier shall be less than the BS R2D channel bandwidth.

6.5.3 Adjacent Channel Leakage Power Ratio

6.5.3.1 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 requirement shall apply during the transmitter ON period.

6.5.3.2 Limits and *Basic limits*

The ACLR is defined with a square filter of bandwidth equal to the transmission bandwidth configuration of the transmitted signal (BW_{Config}) centred on the assigned channel frequency and a filter centred on the adjacent channel frequency according to the tables below.

For operation in paired spectrum, the ACLR shall be higher than the value specified in table 6.5.3.2-1 in band n5, n8 and n28.

Table 6.5.3.2-1: Base station ACLR limit

***BS R2D channel bandwidth* of *lowest/highest carrier* transmitted $BW_{Channel}$ (kHz)**	**BS adjacent channel centre frequency offset below the lowest or above the highest carrier centre frequency transmitted (kHz)**	**Assumed adjacent channel carrier (informative)**	**Filter on the adjacent channel frequency and corresponding filter bandwidth**	**ACLR limit**
200	300	A-IoT of same BW	Square (180 kHz)	40dB
	500	A-IoT of same BW	Square (180 kHz)	45dB
400	500	A-IoT of same BW	Square (360 kHz)	40dB
	900	A-IoT of same BW	Square (360 kHz)	45dB
600	700	A-IoT of same BW	Square (540 kHz)	40dB
	1300	A-IoT of same BW	Square (540 kHz)	45dB
800	900	A-IoT of same BW	Square (720 kHz)	40dB
	1700	A-IoT of same BW	Square (720 kHz)	45dB

6.5.3.3 Minimum requirement for *BS type 1-C*

The ACLR limits in table 6.5.3.2-1 shall apply for each antenna connector.

6.5.4 Operating band unwanted emissions

6.5.4.1 General

Unless otherwise stated, the operating band unwanted emission (OBUE) limits in FR1 are defined from 10MHz below the lowest frequency of each supported downlink operating band up to 10MHz above the highest frequency of each supported downlink operating band. The values of 10MHz are defined in table 6.5.1-1 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.

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_offset_{max} is the offset to the frequency 10MHz outside the downlink *operating band*.
- Δf_{max} is equal to f_offset_{max} minus half of the bandwidth of the measuring filter.

For Medium Range BS, the requirements in clause 6.5.4.2.3 shall apply.

6.5.4.2 *Basic limits*

For A-IoT medium range BS (maximum output power $31 < P_{rated,c} \leq 38$ dBm), emissions shall not exceed the maximum levels specified in Table 6.5.4.2.3-1.

Table 6.5.4.2.3-1: A-IoT medium range BS operating band unwanted emission limits, BS maximum output power $31 < P_{rated,c} \leq 38$ dBm

BS R2D channel bandwidth	Frequency offset of measurement filter -3dB point, Δf	Frequency offset of measurement filter centre frequency, f_offset	Minimum requirement	Measurement bandwidth
200kHz	0 MHz ≤ Δf < 0.05 MHz	0.015 MHz ≤ f_offset < 0.065 MHz	$P_{rated,c}$ - 38dB – $60\left(\frac{f\_offset}{MHz} - 0.015\right)$ dB	30 kHz
	0.05 MHz ≤ Δf < 0.15 MHz	0.065 MHz ≤ f_offset < 0.165 MHz	$P_{rated,c}$ - 41dB – $160\left(\frac{f\_offset}{MHz} - 0.065\right)$ dB	30 kHz
	0.15 MHz ≤ Δf < 0.6 MHz	0.165MHz ≤ f_offset < 0.615MHz	$P_{rated,c}$ - 58dB – $\frac{5}{3}\left(\frac{f\_offset}{MHz} - 0.015\right)$ dB	30 kHz
	0.6 MHz ≤ Δf < 1 MHz	0.615MHz ≤ f_offset < 1.015MHz	$P_{rated,c}$ - 53dB – $15\left(\frac{f\_offset}{MHz} - 0.215\right)$ dB	30 kHz
	1 MHz ≤ Δf ≤ 2.8 MHz	1.5 MHz ≤ f_offset < 3.3 MHz	$P_{rated,c}$ - 52 dB	1 MHz
	2.8 MHz ≤ Δf ≤ 5 MHz	3.3 MHz ≤ f_offset < 5.5 MHz	min($P_{rated,c}$ - 52 dB, -15dBm)	1 MHz
	5 MHz ≤ Δf ≤ Δf_{max}	5.5 MHz ≤ f_offset < f_offset_{max}	$P_{rated,c}$ - 56 dB	1 MHz
400kHz	0 MHz ≤ Δf < 0.4 MHz	0.015 MHz ≤ f_offset < 0.415 MHz	$P_{rated,c}$ -40dB - $\frac{11}{0.4}$ ($\frac{f\_offset}{MHz}$ - 0.015) dB	30 kHz
	0.4 MHz ≤ Δf < 0.8 MHz	0.415 MHz ≤ f_offset < 0.815 MHz	$P_{rated,c}$ - 51dB- $\frac{5}{0.4}$ ($\frac{f\_offset}{MHz}$-0.415) dB	30 kHz
	0.8 MHz ≤ Δf < 1.6 MHz	0.815 MHz ≤ f_offset < 1.6 MHz	$P_{rated,c}$ - 56dB	30 kHz
	1.6 MHz ≤ Δf < Δfmax	1.6 MHz ≤ f_offset < f_offsetmax	-25dBm	100kHz
600kHz	0 MHz ≤ Δf < 0.6 MHz	0.015 MHz ≤ f_offset < 0.615 MHz	$P_{rated,c}$ – 40dB - $\frac{13}{0.6}$ ($\frac{f\_offset}{MHz}$-0.015) dB	30 kHz
	0.6 MHz ≤ Δf < 1.2 MHz	0.615 MHz ≤ f_offset < 1.2 MHz	$P_{rated,c}$ – 53dB - $\frac{5}{0.6}$ ($\frac{f\_offset}{MHz}$-0.615) dB	30 kHz
	1.2 MHz ≤ Δf < 1.8 MHz	1.2 MHz ≤ f_offset < 1.8 MHz	$P_{rated,c}$ - 58dB	30 kHz
	1.8 MHz ≤ Δf < Δfmax	1.8 MHz ≤ f_offset < f_offsetmax	-25dBm	100K
800kHz	0 MHz ≤ Δf < 0.8 MHz	0.015 MHz ≤ f_offset < 0.815 MHz	$P_{rated,c}$ – 40dB- $\frac{14}{0.8}$ ($\frac{f\_offset}{MHz}$-0.015) dB	30 kHz
	0.8 MHz ≤ Δf < 1.6 MHz	0.815 MHz ≤ f_offset < 1.6 MHz	$P_{rated,c}$ – 54dB- $\frac{5}{0.8}$ ($\frac{f\_offset}{MHz}$-0.815) dB	30 kHz
	1.6 MHz ≤ Δf < 2.4 MHz	1.6 MHz ≤ f_offset < 2.4 MHz	$P_{rated,c}$ - 59dB	30 kHz
	2.4 MHz ≤ Δf < Δfmax	2.4 MHz ≤ f_offset < f_offsetmax	-25dBm	100K

For A-IoT (maximum output power $P_{rated,c} \leq 31$ dBm), emissions shall not exceed the maximum levels specified in Tables 6.5.4.2.3-2.

Table 6.5.4.2.3-2: A-IoT medium range BS operating band unwanted emission limits, BS maximum output power $P_{rated,c} \leq 31$ dBm

BS R2D channel bandwidth	Frequency offset of measurement filter -3dB point, Δf	Frequency offset of measurement filter centre frequency, f_offset	Minimum requirement	Measurement bandwidth
200kHz	0 MHz ≤ Δf < 0.05 MHz	0.015 MHz ≤ f_offset < 0.065 MHz	$Max(-7dBm - 60 \cdot \left(\frac{f_{offset}}{MHz} - 0.015\right) dB + XdB, -27dBm)$	30 kHz
	0.05 MHz ≤ Δf < 0.15 MHz	0.065 MHz ≤ f_offset < 0.165 MHz	$Max(-10dBm - 160 \cdot \left(\frac{f_{offset}}{MHz} - 0.065\right) dB + XdB, -27dBm)$	30 kHz
	0.15 MHz ≤ Δf < 0.6 MHz	0.165MHz ≤ f_offset < 0.615MHz	$-27dBm - \frac{5}{3}\left(\frac{f\_offset}{MHz} - 0.015\right) dB$	30 kHz
	0.6 MHz ≤ Δf < 1 MHz	0.615MHz ≤ f_offset < 1.015MHz	$-22dBm - 15 \cdot \left(\frac{f\_offset}{MHz} - 0.215\right) dB$	30 kHz
	1 MHz ≤ Δf ≤ 5 MHz	1.5 MHz ≤ f_offset < 5.5 MHz	-21 dBm	1 MHz
	5 MHz ≤ Δf ≤ Δf_{max}	5.5 MHz ≤ f_offset < f_offset_{max}	-25 dBm	1 MHz
400kHz	0 MHz ≤ Δf < 0.4 MHz	0.015 MHz ≤ f_offset < 0.415 MHz	-9dBm - $\frac{11}{0.4}$ ($\frac{f\_offset}{MHz}$ - 0.015) dB	30 kHz
	0.4 MHz ≤ Δf < 0.8 MHz	0.415 MHz ≤ f_offset < 0.815 MHz	-20dBm- $\frac{5}{0.4}$ ($\frac{f\_offset}{MHz}$-0.415) dB	30 kHz
	0.8 MHz ≤ Δf < 1.6 MHz	0.815 MHz ≤ f_offset < 1.6 MHz	-25dBm	30 kHz
	1.6 MHz ≤ Δf < Δfmax	1.6 MHz ≤ f_offset < f_offsetmax	-25dBm	100kHz
600kHz	0 MHz ≤ Δf < 0.6 MHz	0.015 MHz ≤ f_offset < 0.615 MHz	-9dBm - $\frac{13}{0.6}$ ($\frac{f\_offset}{MHz}$-0.015) dB	30 kHz
	0.6 MHz ≤ Δf < 1.2 MHz	0.615 MHz ≤ f_offset < 1.2 MHz	-22dBm - $\frac{5}{0.6}$ ($\frac{f\_offset}{MHz}$-0.615) dB	30 kHz
	1.2 MHz ≤ Δf < 1.8 MHz	1.2 MHz ≤ f_offset < 1.8 MHz	-27dBm	30 kHz
	1.8 MHz ≤ Δf < Δfmax	1.8 MHz ≤ f_offset < f_offsetmax	-25dBm	100K
800kHz	0 MHz ≤ Δf < 0.8 MHz	0.015 MHz ≤ f_offset < 0.815 MHz	-9dBm - $\frac{14}{0.8}$ ($\frac{f\_offset}{MHz}$-0.015) dB	30 kHz
	0.8 MHz ≤ Δf < 1.6 MHz	0.815 MHz ≤ f_offset < 1.6 MHz	-23dBm - $\frac{5}{0.8}$ ($\frac{f\_offset}{MHz}$-0.815) dB	30 kHz
	1.6 MHz ≤ Δf < 2.4 MHz	1.6 MHz ≤ f_offset < 2.4 MHz	-28dBm	30 kHz
	2.4 MHz ≤ Δf < Δfmax	2.4 MHz ≤ f_offset < f_offsetmax	-25dBm	100kHz

6.5.4.3 Minimum requirements for *BS type 1-C*

The operating band unwanted emissions for BS type 1-C for each antenna connector shall be below the applicable basic limits defined in clause 6.5.4.2.

6.5.5 Transmitter spurious emissions

6.5.5.1 General

The transmitter spurious emission limits shall apply from 9 kHz to 12.75 GHz, excluding the frequency range from 10MHz below the lowest frequency of each supported downlink operating band, up to 10MHz above the highest frequency of each supported downlink operating band.

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

6.5.5.2 Basic limits

6.5.5.2.1 General transmitter spurious emissions requirements

The basic limits of either table 6.5.5.2.1-1 (Category A limits) or table 6.5.5. 2.1-2 (Category B limits) shall apply.

Table 6.5.5.2.1-1: General BS transmitter spurious emission limits in FR1, Category A

Spurious frequency range	*Basic limit*	*Measurement bandwidth*
9 kHz – 150 kHz	-13 dBm	1 kHz
150 kHz – 30 MHz		10 kHz
30 MHz – 1 GHz		100 kHz
1 GHz 12.75 GHz		1 MHz

Table 6.5.5.2.1-2: General BS transmitter spurious emission limits in FR1, Category B

Spurious frequency range	*Basic limit*	*Measurement bandwidth*
9 kHz – 150 kHz	-36 dBm	1 kHz
150 kHz – 30 MHz		10 kHz
30 MHz – 1 GHz		100 kHz
1 GHz – 12.75 GHz	-30 dBm	1 MHz

6.5.5.2.2 Additional spurious emissions requirements

These requirements may be applied for the protection of system operating in frequency ranges other than the BS downlink operating band. The limits may apply as an optional protection of such systems that are deployed in the same geographical area as the BS, or they may be set by local or regional regulation as a mandatory requirement for an NR operating band. It is in some cases not stated in the present document whether a requirement is mandatory or under what exact circumstances that a limit applies, since this is set by local or regional regulation. An overview of regional requirements in the present document is given in clause 4.5.

Some requirements may apply for the protection of specific equipment (UE, MS and/or BS) or equipment operating in specific systems (GSM, CDMA, UTRA, E-UTRA, NR, etc.) as listed below.

The spurious emission *basic limits* are provided in table 6.5.5.2.2 -1 for a BS where requirements for co-existence with the system listed in the first column apply.

Table 6.5.5.2.2-1: BS spurious emissions *basic limits* for BS for co-existence with systems operating in other frequency bands

System type for A-IoT to co-exist with	Frequency range for co-existence requirement	*Basic limits*	*Measurement bandwidth*	Note
DCS1800	1805 – 1880 MHz	-47 dBm	100 kHz	This requirement does not apply to BS operating in band n3.
	1710 – 1785 MHz	-61 dBm	100 kHz	This requirement does not apply to BS operating in band n3, since it is already covered by the requirement in clause 6.5.5.2.2.
PCS1900	1930 – 1990 MHz	-47 dBm	100 kHz	This requirement does not apply to BS operating in band n2, n25 or band n70.
	1850 – 1910 MHz	-61 dBm	100 kHz	This requirement does not apply to BS operating in band n2 or n25 since it is already covered by the requirement in clause 6.5.5.2.2.
GSM850 or CDMA850	869 – 894 MHz	-57 dBm	100 kHz	This requirement does not apply to BS operating in band n5 or n26.
	824 – 849 MHz	-61 dBm	100 kHz	This requirement does not apply to BS operating in band n5 or n26, since it is already covered by the requirement in clause 6.5.5.2.2.
UTRA FDD Band I or E-UTRA Band 1 or NR Band n1	2110 – 2170 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n1 or n65
	1920 – 1980 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n1 or n65, since it is already covered by the requirement in clause 6.5.5.2.2.
UTRA FDD Band II or E-UTRA Band 2 or NR Band n2	1930 – 1990 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n2 or n70.
	1850 – 1910 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n2, since it is already covered by the requirement in clause 6.5.5.2.2.
UTRA FDD Band III or E-UTRA Band 3 or NR Band n3	1805 – 1880 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n3.
	1710 – 1785 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n3, since it is already covered by the requirement in clause 6.5.5.2.2.
UTRA FDD Band IV or E-UTRA Band 4	2110 – 2155 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n66
	1710 – 1755 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n66, since it is already covered by the requirement in clause 6.5.5.2.2.
UTRA FDD Band V or E-UTRA Band 5 or NR Band n5	869 – 894 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n5 or n26.
	824 – 849 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n5 or n26, since it is already covered by the requirement in clause 6.5.5.2.2.
UTRA FDD Band VI, XIX or E-UTRA Band 6, 18, 19 or NR Band n18	860 – 890 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n18.
	815 – 830 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n18, since it is already covered by the requirement in clause 6.5.5.2.2.
	830 – 845 MHz	-49 dBm	1 MHz	
UTRA FDD Band VII or E-UTRA Band 7 or NR Band n7	2620 – 2690 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n7.
	2500 – 2570 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n7, since it is already covered by the requirement in clause 6.5.5.2.2.
UTRA FDD Band IX or E-UTRA Band 9	1844.9 – 1879.9 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n3.
	1749.9 – 1784.9 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n3, since it is already covered by the requirement in clause 6.5.5.2.2.
UTRA FDD Band X or	2110 – 2170 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n66

System type for A-IoT to co-exist with	Frequency range for co-existence requirement	*Basic limits*	*Measurement bandwidth*	Note
E-UTRA Band 10	1710 – 1770 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n66, since it is already covered by the requirement in clause 6.5.5.2.2.
UTRA FDD Band XI or XXI or E-UTRA Band 11 or 21	1475.9 – 1510.9 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n50, n74, n75, n92, n94 or n109.
	1427.9 – 1447.9 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n50, n51, n74, n75, n76, n91, n92, n93, or n109.
	1447.9 – 1462.9 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n50, n74, n75, n92, n94 or n109.
UTRA FDD Band XII or E-UTRA Band 12 or NR Band n12	729 – 746 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n12 or n85.
	699 – 716 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n12 or n85, since it is already covered by the requirement in clause 6.5.5.2.2. For NR BS operating in n29, it applies 1 MHz below the Band n29 downlink operating band (Note 5).
UTRA FDD Band XIII or E-UTRA Band 13 or NR Band n13	746 – 756 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n13.
	777 – 787 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n13, since it is already covered by the requirement in clause 6.5.5.2.2.
UTRA FDD Band XIV or E-UTRA Band 14 or NR band n14	758 – 768 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n14.
	788 – 798 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n14, since it is already covered by the requirement in clause 6.5.5.2.2.
E-UTRA Band 17	734 – 746 MHz	-52 dBm	1 MHz	
	704 – 716 MHz	-49 dBm	1 MHz	For NR BS operating in n29, it applies 1 MHz below the Band n29 downlink operating band (Note 5).
UTRA FDD Band XX or E-UTRA Band 20 or NR Band n20	791 – 821 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n20 or n28.
	832 – 862 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n20, since it is already covered by the requirement in clause 6.5.5.2.2.
UTRA FDD Band XXII or E-UTRA Band 22	3510 – 3590 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n48, n77 or n78.
	3410 – 3490 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n77 or n78.
E-UTRA Band 24 or NR Band n24	1525 – 1559 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n24.
	1626.5 – 1660.5 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n24, since it is already covered by the requirement in clause 6.5.5.2.2.
UTRA FDD Band XXV or E-UTRA Band 25 or NR band n25	1930 – 1995 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n2, n25 or n70.
	1850 – 1915 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n25 since it is already covered by the requirement in clause 6.5.5.2.2. For BS operating in Band n2, it applies for 1910 MHz to 1915 MHz, while the rest is covered in clause 6.5.5.2.2.
UTRA FDD Band XXVI or E-UTRA Band 26 or NR Band n26	859 – 894 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n5 or n26.
	814 – 849 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n26 since it is already covered by the requirement in clause 6.5.5.2.2. For BS operating in Band n5, it applies for 814 MHz to 824 MHz, while the rest is covered in clause 6.5.5.2.2.
	852 – 869 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n5.

System type for A-IoT to co-exist with	Frequency range for co-existence requirement	*Basic limits*	*Measurement bandwidth*	Note
E-UTRA Band 27	807 – 824 MHz	-49 dBm	1 MHz	This requirement also applies to BS operating in Band n28, starting 4 MHz above the Band n28 downlink *operating band* (Note 5).
E-UTRA Band 28 or NR Band n28	758 – 803 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n20, n67 or n28.
	703 – 748 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n28, since it is already covered by the requirement in clause 6.5.5.2.2. For BS operating in band n67, it applies for 703 MHz to 736 MHz.
E-UTRA Band 29 or NR Band n29	717 – 728 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n29 or n85
E-UTRA Band 30 or NR Band n30	2350 – 2360 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n30
	2305 – 2315 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n30, since it is already covered by the requirement in clause 6.5.5.2.2.
E-UTRA Band 31 or NR Band n31	462.5 – 467.5 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n31 or n72.
	452.5 – 457.5 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n31, since it is already covered by the requirement in clause 6.5.5.2.2. This requirement does not apply to BS operating in band n72.
UTRA FDD band XXXII or E-UTRA band 32	1452 – 1496 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n50, n74, n75, n92, n94 or n109
UTRA TDD Band a) or E-UTRA Band 33	1900 – 1920 MHz	-52 dBm	1 MHz	
UTRA TDD Band a) or E-UTRA Band 34 or NR band n34	2010 – 2025 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n34.
UTRA TDD Band b) or E-UTRA Band 35	1850 – 1910 MHz	-52 dBm	1 MHz	
UTRA TDD Band b) or E-UTRA Band 36	1930 – 1990 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n2 or n25.
UTRA TDD Band c) or E-UTRA Band 37	1910 – 1930 MHz	-52 dBm	1 MHz	
UTRA TDD Band d) or E-UTRA Band 38 or NR Band n38	2570 – 2620 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n38.
UTRA TDD Band f) or E-UTRA Band 39 or NR band n39	1880 – 1920MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n39.
UTRA TDD Band e) or E-UTRA Band 40 or NR Band n40	2300 – 2400MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n30 or n40.

System type for A-IoT to co-exist with	Frequency range for co-existence requirement	*Basic limits*	*Measurement bandwidth*	Note
E-UTRA Band 41 or NR Band n41, n90	2496 – 2690 MHz	-52 dBm	1 MHz	This is not applicable to BS operating in Band n41, n53 or [n90].
E-UTRA Band 42	3400 – 3600 MHz	-52 dBm	1 MHz	This is not applicable to BS operating in Band n48, n77 or n78.
E-UTRA Band 43	3600 – 3800 MHz	-52 dBm	1 MHz	This is not applicable to BS operating in Band n48, n77 or n78.
E-UTRA Band 44	703 – 803 MHz	-52 dBm	1 MHz	This is not applicable to BS operating in Band n28.
E-UTRA Band 45	1447 – 1467 MHz	-52 dBm	1 MHz	
E-UTRA Band 46 or NR Band n46	5150 – 5925 MHz	-52 dBm	1 MHz	This is not applicable to BS operating in Band n46, n96 or n102.
E-UTRA Band 47	5855 – 5925 MHz	-52 dBm	1 MHz	
E-UTRA Band 48 or NR Band n48	3550 – 3700 MHz	-52 dBm	1 MHz	This is not applicable to BS operating in Band n48, n77 or n78.
E-UTRA Band 50 or NR band n50	1432 – 1517 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n50, n51, n74, n75, n76, n91, n92, n93, n94 or n109.
E-UTRA Band 51 or NR Band n51	1427 – 1432 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n50, n51, n75, n76, n91, n92, n93, n94 or n109.
E-UTRA Band 53 or NR Band n53	2483.5 - 2495 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n41, n53 or n90.
E-UTRA Band 54 or NR Band n54	1670 – 1675 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n54
E-UTRA Band 65 or NR Band n65	2110 – 2200 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n1 or n65.
	1920 – 2010 MHz	-49 dBm	1 MHz	For BS operating in Band n1, it applies for 1980 MHz to 2010 MHz, while the rest is covered in clause 6.5.5.2.2. This requirement does not apply to BS operating in band n65, since it is already covered by the requirement in clause 6.5.5.2.2.
E-UTRA Band 66 or NR Band n66	2110 – 2200 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n66.
	1710 – 1780 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n66, since it is already covered by the requirement in clause 6.5.5.2.2.
E-UTRA Band 67 or NR Band n67	738 – 758 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n28 or n67.
E-UTRA Band 68	753 -783 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n28.
	698-728 MHz	-49 dBm	1 MHz	For BS operating in Band n28, this requirement applies between 698 MHz and 703 MHz, while the rest is covered in clause 6.5.5.2.2.
E-UTRA Band 69	2570 – 2620 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n38.
E-UTRA Band 70 or NR Band n70	1995 – 2020 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n2, n25 or n70
	1695 – 1710 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n70, since it is already covered by the requirement in clause 6.5.5.2.2.
E-UTRA Band 71 or	617 – 652 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n71 or n105

System type for A-IoT to co-exist with	Frequency range for co-existence requirement	*Basic limits*	*Measurement bandwidth*	Note
NR Band n71	663 – 698 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n71 or n105, since it is already covered by the requirement in clause 6.5.5.2.2.
E-UTRA Band 72 or NR Band n72	461 – 466 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n31 or n72.
	451 – 456 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n72, since it is already covered by the requirement in clause 6.5.5.2.2. This requirement does not apply to BS operating in band n31.
E-UTRA Band 74 or NR Band n74	1475 – 1518 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n50, n74, n75, n92, n94 or n109.
	1427 – 1470 MHz	-49 dBm	1MHz	This requirement does not apply to BS operating in band n50, n51, n74, n75, n76, n91, n92, n93 or n94 or n109.
E-UTRA Band 75 or NR Band n75	1432 – 1517 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n50, n51, n74, n75, n76, n91, n92, n93 or n94 or n109.
E-UTRA Band 76 or NR Band n76	1427 – 1432 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n50, n51, n75, n76, n91, n92, n93, n94 or n109.
NR Band n77	3.3 – 4.2 GHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n48, n77 or n78
NR Band n78	3.3 – 3.8 GHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n48, n77 or n78
NR Band n79	4.4 – 5.0 GHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n79
NR Band n80	1710 – 1785 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n3, since it is already covered by the requirement in clause 6.5.5.2.2.
NR Band n82	832 – 862 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n20, since it is already covered by the requirement in clause 6.5.5.2.2.
NR Band n83	703 – 748 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n28, since it is already covered by the requirement in clause 6.5.5.2.2. For BS operating in Band n67, it applies for 703 MHz to 736 MHz.
NR Band n84	1920 – 1980 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n1, since it is already covered by the requirement in clause 6.5.5.2.2.
E-UTRA Band 85 or NR Band n85	728 – 746 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n12 or n85. For NR BS operating in n29, it applies 1 MHz below the Band n29 downlink operating band (Note 5).
	698 – 716 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n12 or n85, since it is already covered by the requirement in clause 6.5.5.2.2.
NR Band n86	1710 – 1780 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n66, since it is already covered by the requirement in clause 6.5.5.2.2.
NR Band n89	824 – 849 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n5, since it is already covered by the requirement in clause 6.5.5.2.2.
NR Band n91	1427 – 1432 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n50, n51, n75, n76 or n109
	832 – 862 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n20, since it is already covered by the requirement in clause 6.5.5.2.2.
NR Band n92	1432 – 1517 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n50, n51, n74, n75, n76 or n109.
	832 – 862 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n20, since it is already covered by the requirement in clause 6.5.5.2.2.

System type for A-IoT to co-exist with	Frequency range for co-existence requirement	*Basic limits*	*Measurement bandwidth*	Note
	1427 – 1432 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n50, n51, n75, n76 or n109.
	1432 – 1517 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n50, n51, n74, n75, n76 or n109.
NR Band n95	2010 – 2025 MHz	-52 dBm	1 MHz	
NR Band n96	5925 – 7125 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n46, n96, n102 or n104.
NR Band n97	2300 – 2400MHz	-52 dBm	1 MHz	
NR Band n98	1880 – 1920MHz	-52 dBm	1 MHz	
NR Band n99	1626.5 – 1660.5 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n24, since it is already covered by the requirement in clause 6.5.5.2.2.
	874.4 – 880 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n100, since it is already covered by the requirement in clause 6.5.5.2.2.
NR band n101	1900 – 1910 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n101.
NR Band n102	5925 – 6425 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n46, n96, n102 or n104.
E-UTRA Band 103	757 – 758 MHz	-52 dBm	1 MHz	
	787 – 788 MHz	-49 dBm	1 MHz	
NR Band n104	6425 – 7125 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n96, n102 or n104
NR Band n105	612 – 652 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n71 or n105
	663 – 703 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in n105, since it is already covered by the requirement in clause 6.5.5.2.2.
E-UTRA Band 106 or NR Band n106	935 - 940 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n106
	896 – 901 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in Band n5 or n26. This requirement does not apply to BS operating in n106, since it is already covered by the requirement in clause 6.5.5.2.2.
NR Band n109	1432 – 1517 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in Band n50, n51, n74, n75, n76, n91, n92, n93, n94 or n109
	703 –733MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n28, since it is already covered by the requirement in clause 6.5.5.2.2.

NOTE 1: As defined in the scope for spurious emissions in this clause, except for the cases where the noted requirements apply to a BS operating in Band n28, the co-existence requirements in table 6.5.5.2.3 -1 do not apply for the 10MHz frequency range immediately outside the downlink *operating band* (see table 5.2-1). Emission limits for this excluded frequency range may be covered by local or regional requirements.

NOTE 2: Table 6.5.5.2.3 -1 assumes that two *operating bands*, where the frequency ranges in table 5.2-1 would be overlapping, are not deployed in the same geographical area. For such a case of operation with overlapping frequency arrangements in the same geographical area, special co-existence requirements may apply that are not covered by the 3GPP specifications.

Table 6.5.5.2.3-3: Void

6.5.5.2.3 Co-location with other base stations

These requirements may be applied for the protection of other BS receivers when GSM900, DCS1800, PCS1900, GSM850, CDMA850, UTRA FDD, UTRA TDD, E-UTRA and/or NR BS are co-located with a BS.

The requirements assume a 30 dB coupling loss between transmitter and receiver and are based on co-location with base stations of the same class.

The *basic limits* are in table 6.5.5.2.3-1 for a BS where requirements for co-location with a BS type listed in the first column apply, depending on the declared Base Station class.

Table 6.5.5.2.3-1: BS spurious emissions *basic* limits for BS co-located with another BS

Type of co-located BS	Frequency range for co-location requirement	*Basic limits* MR BS	Measurement bandwidth	Note
DCS1800	1710 – 1785 MHz	-91 dBm	100 kHz	
PCS1900	1850 – 1910 MHz	-91 dBm	100 kHz	
GSM850 or CDMA850	824 – 849 MHz	-91 dBm	100 kHz	
UTRA FDD Band I or E-UTRA Band 1 or NR Band n1	1920 – 1980 MHz	-91 dBm	100 kHz	
UTRA FDD Band II or E-UTRA Band 2 or NR Band n2	1850 – 1910 MHz	-91 dBm	100 kHz	
UTRA FDD Band III or E-UTRA Band 3 or NR Band n3	1710 – 1785 MHz	-91 dBm	100 kHz	
UTRA FDD Band IV or E-UTRA Band 4	1710 – 1755 MHz	-91 dBm	100 kHz	
UTRA FDD Band V or E-UTRA Band 5 or NR Band n5	824 – 849 MHz	-91 dBm	100 kHz	
UTRA FDD Band VI, XIX or E-UTRA Band 6, 19	830 – 845 MHz	-91 dBm	100 kHz	
UTRA FDD Band VII or E-UTRA Band 7 or NR Band n7	2500 – 2570 MHz	-91 dBm	100 kHz	
UTRA FDD Band IX or E-UTRA Band 9	1749.9 – 1784.9 MHz	-91 dBm	100 kHz	
UTRA FDD Band X or E-UTRA Band 10	1710 – 1770 MHz	-91 dBm	100 kHz	
UTRA FDD Band XI or E-UTRA Band 11	1427.9 –1447.9 MHz	-91 dBm	100 kHz	This is not applicable to BS operating in Band n50, n75, n91, n92, n93 or n94
UTRA FDD Band XII or E-UTRA Band 12 or NR Band n12	699 – 716 MHz	-91 dBm	100 kHz	
UTRA FDD Band XIII or E-UTRA Band 13 or NR Band n13	777 – 787 MHz	-91 dBm	100 kHz	
UTRA FDD Band XIV or E-UTRA Band 14 or NR Band n14	788 – 798 MHz	-91 dBm	100 kHz	
E-UTRA Band 17	704 – 716 MHz	-91 dBm	100 kHz	
E-UTRA Band 18 or NR Band n18	815 – 830 MHz	-91 dBm	100 kHz	
UTRA FDD Band XX or E-UTRA Band 20 or NR Band n20	832 – 862 MHz	-91 dBm	100 kHz	
UTRA FDD Band XXI or E-UTRA Band 21	1447.9 – 1462.9 MHz	-91 dBm	100 kHz	This is not applicable to BS operating in Band n50, n75, n92 or n94
UTRA FDD Band XXII or E-UTRA Band 22	3410 – 3490 MHz	-91 dBm	100 kHz	This is not applicable to BS operating in Band n48, n77 or n78
E-UTRA Band 24 or NR Band n24	1626.5 – 1660.5 MHz	-91 dBm	100 kHz	
UTRA FDD Band XXV or E-UTRA Band 25 or NR Band n25	1850 – 1915 MHz	-91 dBm	100 kHz	

UTRA FDD Band XXVI or E-UTRA Band 26 or NR Band n26	814 – 849 MHz	-91 dBm	100 kHz	
E-UTRA Band 27	807 – 824 MHz	-91 dBm	100 kHz	
E-UTRA Band 28 or NR Band n28	703 – 748 MHz	-91 dBm	100 kHz	
E-UTRA Band 30 or NR Band n30	2305 – 2315 MHz	-91 dBm	100 kHz	
E-UTRA Band 31 or NR Band n31	452.5 – 457.5 MHz	-91 dBm	100 kHz	
UTRA TDD Band a) or E-UTRA Band 33	1900 – 1920 MHz	-91 dBm	100 kHz	
UTRA TDD Band a) or E-UTRA Band 34 or NR band n34	2010 – 2025 MHz	-91 dBm	100 kHz	This is not applicable to BS operating in Band n34
UTRA TDD Band b) or E-UTRA Band 35	1850 – 1910 MHz	-91 dBm	100 kHz	
UTRA TDD Band b) or E-UTRA Band 36	1930 – 1990 MHz	-91 dBm	100 kHz	This is not applicable to BS operating in Band n2 or band n25
UTRA TDD Band c) or E-UTRA Band 37	1910 – 1930 MHz	-91 dBm	100 kHz	
UTRA TDD Band d) or E-UTRA Band 38 or NR Band n38	2570 – 2620 MHz	-91 dBm	100 kHz	This is not applicable to BS operating in Band n38.
UTRA TDD Band f) or E-UTRA Band 39 or NR band n39	1880 – 1920MHz	-91 dBm	100 kHz	This is not applicable to BS operating in Band n39
UTRA TDD Band e) or E-UTRA Band 40 or NR Band n40	2300 – 2400MHz	-91 dBm	100 kHz	This is not applicable to BS operating in Band n30 or n40.
E-UTRA Band 41 or NR Band n41, n90	2496 – 2690 MHz	-91 dBm	100 kHz	This is not applicable to BS operating in Band n41, n53 or [n90]
E-UTRA Band 42	3400 – 3600 MHz	-91 dBm	100 kHz	This is not applicable to BS operating in Band n48, n77 or n78
E-UTRA Band 43	3600 – 3800 MHz	-91 dBm	100 kHz	This is not applicable to BS operating in Band n48, n77 or n78
E-UTRA Band 44	703 – 803 MHz	-91 dBm	100 kHz	This is not applicable to BS operating in Band n28
E-UTRA Band 45	1447 – 1467 MHz	-91 dBm	100 kHz	
E-UTRA Band 46 or NR Band n46	5150 – 5925 MHz	-91 dBm	100 kHz	This is not applicable to BS operating in Band n46, n96 or n102
E-UTRA Band 48 or NR Band n48	3550 – 3700 MHz	-91 dBm	100 kHz	This is not applicable to BS operating in Band n48, n77 or n78

E-UTRA Band 50 or NR Band n50	1432 – 1517 MHz	-91 dBm	100 kHz	This is not applicable to BS operating in Band n51, n74, n75, n91, n92, n93 or n94
E-UTRA Band 51 or NR Band n51	1427 – 1432 MHz	N/A	100 kHz	This is not applicable to BS operating in Band n50, n74, n75, n76, n91, n92, n93 or n94
E-UTRA Band 53 or NR Band n53	2483.5 – 2495 MHz	-91 dBm	100 kHz	This is not applicable to BS operating in Band n41, n53 or n90
E-UTRA Band 54 or NR Band n54	1670 – 1675 MHz	-91 dBm	100 kHz	This is not applicable to BS operating in Band n54
E-UTRA Band 65 or NR Band n65	1920 – 2010 MHz	-91 dBm	100 kHz	
E-UTRA Band 66 or NR Band n66	1710 – 1780 MHz	-91 dBm	100 kHz	
E-UTRA Band 68	698 – 728 MHz	-91 dBm	100 kHz	
E-UTRA Band 70 or NR Band n70	1695 – 1710 MHz	-91 dBm	100 kHz	
E-UTRA Band 71 or NR Band n71	663 – 698 MHz	-91 dBm	100 kHz	
E-UTRA Band 72 or NR Band n72	451 – 456 MHz	-91 dBm	100 kHz	
E-UTRA Band 74 or NR Band n74	1427 – 1470 MHz	-91 dBm	100 kHz	This is not applicable to BS operating in Band n50, n51, n91, n92, n93 or n94
NR Band n77	3.3 – 4.2 GHz	-91 dBm	100 kHz	This is not applicable to BS operating in Band n48, n77 or n78
NR Band n78	3.3 – 3.8 GHz	-91 dBm	100 kHz	This is not applicable to BS operating in Band n48, n77 or n78
NR Band n79	4.4 – 5.0 GHz	-91 dBm	100 kHz	
NR Band n80	1710 – 1785 MHz	-91 dBm	100 kHz	
NR Band n82	832 – 862 MHz	-91 dBm	100 kHz	
NR Band n83	703 – 748 MHz	-91 dBm	100 kHz	
NR Band n84	1920 – 1980 MHz	-91 dBm	100 kHz	
E-UTRA Band 85 or NR Band 85	698 – 716 MHz	-91 dBm	100 kHz	
NR Band n86	1710 – 1780 MHz	-91 dBm	100 kHz	
NR Band n89	824 – 849 MHz	-91 dBm	100 kHz	
NR Band n91	832 – 862 MHz	N/A	100 kHz	
NR Band n92	832 – 862 MHz	-91 dBm	100 kHz	
NR Band n95	2010 – 2025 MHz	-91 dBm	100 kHz	
NR Band n96	5925 – 7125 MHz	-90 dBm	100 kHz	This is not applicable to BS operating in Band n46, n96, n102 or n104
NR Band n97	2300 – 2400MHz	-91 dBm	100 kHz	

NR Band n98	1880 – 1920MHz	-91 dBm	100 kHz	
NR Band n99	1626.5 – 1660.5 MHz	-91 dBm	100 kHz	
NR Band n100	874.4 – 880 MHz	NA	100 kHz	
NR Band n101	1900 – 1910 MHz	NA	100 kHz	
NR Band n102	5925 – 6425 MHz	-90 dBm	100 kHz	This is not applicable to BS operating in Band n46, n96, n102 or n104
E-UTRA Band 103	787 – 788 MHz	-91 dBm	100 kHz	
NR Band n104	6425 – 7125 MHz	-90 dBm	100 kHz	This requirement does not apply to BS operating in Band n96, n102 or n104.
NR Band n105	663 – 703 MHz	-91 dBm	100 kHz	
NR Band n109	703 – 733 MHz	-91 dBm	100 kHz	

NOTE 1: As defined in the scope for spurious emissions in this clause, the co-location requirements in table 6.5.5.2.4-1 do not apply for the frequency range extending 10MHz immediately outside the BS transmit frequency range of a downlink *operating band* (see table 5.2-1). The current state-of-the-art technology does not allow a single generic solution for co-location with other system on adjacent frequencies for 30dB BS-BS minimum coupling loss. However, there are certain site-engineering solutions that can be used. These techniques are addressed in TR 25.942 [4].

NOTE 2: Table 6.5.5.2.4-1 assumes that two *operating bands*, where the corresponding BS transmit and receive frequency ranges in table 5.2-1 would be overlapping, are not deployed in the same geographical area. For such a case of operation with overlapping frequency arrangements in the same geographical area, special co-location requirements may apply that are not covered by the 3GPP specifications.

6.5.5.3 Minimum requirements for *BS type 1-C*

The Tx spurious emissions for BS type 1-C for each antenna connector shall not exceed the basic limits specified in clause 6.5.5.2.

7 A-IoT BS receiver characteristics

7.1 General

Conducted receiver characteristics are specified at the *antenna connector* for *BS type 1-C* , with full complement of transceivers for the configuration in normal operating condition.

Unless otherwise stated, the following arrangements apply for conducted receiver characteristics requirements in clause 7:

- Requirements apply during the BS receive period.
- Reference requirements defined for the conducted receiver characteristics do not assume HARQ retransmissions.

NOTE 1: In normal operating condition, A-IoT BS is configured as HD-FDD operation.

7.2 Reference sensitivity level

7.2.1 General

The reference sensitivity power level $P_{REFSENS}$ is the minimum mean power received at the *antenna connector* for *BS type 1-C* at which a BLER requirement shall be met for a specified reference measurement channel.

7.2.2 Minimum requirements for *BS type 1-C*

The BLER shall be less than or equal to 10% of the reference measurement channel as specified in annex A.1 with parameters specified in table 7.2.2-1 for A-IoT Medium range BS.

Table 7.2.2-1: A-IoT Medium range BS reference sensitivity levels

BS D2R channel bandwidth **(KHz)**	**DSB (kHz)**	**Reference measurement channel**	**Reference sensitivity power level, $P_{REFSENS}$ (dBm)**
200	15	A-FR1-A1-1	-95.2
		A-FR1-A1-2	-92.2
3520	2880	A-FR1-A1-3	-72.4
		A-FR1-A1-4	-69.4
NOTE: Reference sensitivity power level is defined based on the CW power at the BS antenna connector as -38dBm without the cancellation of CW phase noise considered.			

7.3 In-band selectivity and blocking

7.3.1 Adjacent Channel Selectivity

7.3.1.1 General

Adjacent channel selectivity (ACS) is a measure of the receiver's ability to receive a wanted signal at its assigned channel frequency at the *antenna connector* for *BS type 1-C* in the presence of an adjacent channel signal with a specified centre frequency offset of the interfering signal to the band edge of a victim system.

7.3.1.2 Minimum requirement for *BS type 1-C*

The MDR performance shall be [1%] of the reference measurement channel.

The wanted and the interfering signal coupled to the *BS type 1-C antenna connector* are specified in table 7.4.1.2-1 and the frequency offset between the wanted and interfering signal in table 7.4.1.2-2 for ACS. The reference measurement channel for the wanted signal is identified in table 7.2.2-1, 7.2.2-2 and 7.2.2-3 for each *BS D2R channel bandwidth* in any operating band and further specified in annex A.1. The characteristics of the interfering signal is further specified in annex D.

The ACS 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.

Minimum conducted requirement is defined at the *antenna connector* for *BS type 1-C.*

Table 7.3.1.2-1: Base station ACS requirement

A-IoT channel bandwidth of the lowest/highest carrier received [kHz]	**Wanted signal mean power [dBm]**	**Interfering signal mean power [dBm]**	**Interfering signal centre frequency offset to the lower/upper Base Station RF Bandwidth edge [kHz]**	**Type of interfering signal**
200	$P_{REFSENS}$ + 6dB (Note)	-53	±100	3 MHz DFT-s-OFDM NR signal, 15 kHz SCS, 1 RB, closest to wanted signal
3520	$P_{REFSENS}$ + 6dB (Note)	-53	±100	3 MHz DFT-s-OFDM NR signal
Note: $P_{REFSENS}$ depends on the sub-carrier spacing as specified in Table 7.2.2-1				

Table 7.3.1.2-2: Base Station ACS interferer frequency offset values

***BS channel bandwidth* of the *lowest/highest carrier* received (kHz)**	**Interfering signal centre frequency offset from the lower/upper *Base Station RF Bandwidth edge* or *sub-block* edge inside a *sub-block gap* (kHz)**	**Type of interfering signal**
200	±100	3 MHz DFT-s-OFDM NR signal, 15 kHz SCS, 1 RB, closest to wanted signal
3520	±100	3 MHz DFT-s-OFDM NR signal

7.3.2 In-band blocking

7.3.2.1 General

The in-band blocking characteristics is a measure of the receiver's ability to receive a wanted signal at its assigned channel at the *antenna connector* for *BS type 1-C* in the presence of an unwanted interferer, which is an NR signal for general blocking or an NR signal with one resource block for narrowband blocking.

7.3.2.2 Minimum requirement for *BS type 1-C*

The MDR performance shall be [1%] of the reference measurement channel, with a wanted and an interfering signal coupled to *BS type 1-C antenna connector* using the parameters in tables 7.3.2.2-1, 7.3.2.2-2 and 7.3.2.2-3 for general blocking and narrowband blocking requirements. The reference measurement channel for the wanted signal is identified in clause 7.2.2 for each *BS channel bandwidth* and further specified in annex A.1. The characteristics of the interfering signal is further specified in annex D.

The in-band blocking requirements apply 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.

The in-band blocking requirement shall apply from $F_{UL,low}$ - Δf_{OOB} to $F_{UL,high}$ + Δf_{OOB}, excluding the downlink frequency range of the FDD *operating band*. The Δf_{OOB} for *BS type 1-C* is defined in table 7.3.2.2-0.

Minimum conducted requirement is defined at the *antenna connector* for *BS type 1-C.*

Table 7.3.2.2-0: Δf_{OOB} offset for NR *operating bands*

BS type	***Operating band* characteristics**	**Δf_{OOB} (MHz)**
BS type 1-C	$F_{UL,high} - F_{UL,low} \leq$ 200 MHz	20
	200 MHz < $F_{UL,high} - F_{UL,low} \leq$ 900 MHz	60

Table 7.3.2.2-1: Base station general blocking requirement

***BS channel bandwidth* of the *lowest/highest carrier* received (kHz)**	**Wanted signal mean power (dBm) (Note 2)**	**Interfering signal mean power (dBm)**	**Interfering signal centre frequency minimum offset from the lower/upper *Base Station RF Bandwidth edge* or *sub-block* edge inside a *sub-block gap* (kHz)**	**Type of interfering signal**
200	$P_{REFSENS}$ + x dB	-38	±7.5	3 MHz DFT-s-OFDM NR signal 15 kHz SCS, 15 RBs
3520	$P_{REFSENS}$ + x dB	-38	±4760	3 MHz DFT-s-OFDM NR signal 15 kHz SCS, 15 RBs
NOTE 1: $P_{REFSENS}$ depends also on the *BS channel bandwidth* as specified in tables 7.2.2-1 NOTE 2: For a BS capable of single band operation only, "x" is equal to 6 dB. For a BS capable of multi-band operation, "x" is equal to 6 dB in case of interfering signals that are in the in-band blocking frequency range of the operating band where the wanted signal is present or in the in-band blocking frequency range of an adjacent or overlapping operating band. For other in-band blocking frequency ranges of the interfering signal for the supported operating bands, "x" is equal to 1.4 dB.				

7.4 Out-of-band blocking

7.4.1 General

The out-of-band blocking characteristics is a measure of the receiver ability to receive a wanted signal at its assigned channel at the *antenna connector* for *BS type 1-C* in the presence of an unwanted interferer out of the *operating band*, which is a CW signal for out-of-band blocking.

7.4.2 Minimum requirement for *BS type 1-C*

the MDR performance shall be [1%] of the reference measurement channel, with a wanted and an interfering signal coupled to *BS type 1-C antenna connector* using the parameters in table 7.5.2-1.

The reference measurement channel for the wanted signal is identified in clause 7.2.2 for each *BS channel bandwidth* and further specified in annex A.1. The characteristics of the interfering signal is further specified in annex D.

The out-of-band blocking requirement apply from 1 MHz to $F_{UL,low}$ - Δf_{OOB} and from $F_{UL,high}$ + Δf_{OOB} up to 12750 MHz, including the downlink frequency range of the FDD *operating band* for BS supporting FDD. The Δf_{OOB} for *BS type 1-C* and *BS type 1-H* is defined in table 7.4.2.2-0.

Minimum conducted requirement is defined at the *antenna connector* for *BS type 1-C.*

Table 7.4.2-1: Out-of-band blocking performance requirement for NR

Wanted Signal mean power (dBm)	Interfering Signal mean power (dBm)	Type of Interfering Signal
$P_{REFSENS}$ +6 dB (Note)	-15	CW carrier
NOTE : $P_{REFSENS}$ depends also on the *BS channel bandwidth* as specified in Table 7.2.2-1.		

7.5 Receiver spurious emissions

7.5.1 General

The receiver spurious emissions power is the power of emissions generated or amplified in a receiver unit that appear at the *antenna connector* (for *BS type 1-C*). The requirements apply to all BS with separate RX and TX *antenna connectors*.

NOTE: In this case for FDD operation the test is performed when both TX and RX are ON, with the TX *antenna connectors* terminated.

For *antenna connectors* supporting both RX and TX in FDD, the RX spurious emissions requirements are superseded by the TX spurious emissions requirements, as specified in clause 6.6.5.

7.5.2 *Basic limits*

The receiver spurious emissions *basic limits* are provided in table 7.6.2-1.

Table 7.5.2-1: General BS receiver spurious emissions limits

Spurious frequency range	*Basic limits*	*Measurement bandwidth*	Note
30 MHz – 1 GHz	-57 dBm	100 kHz	Note 1
1 GHz – 12.75 GHz	-47 dBm	1 MHz	Note 1, Note 2
12.75 GHz – 5th harmonic of the upper frequency edge of the UL *operating band* in GHz	-47 dBm	1 MHz	Note 1, Note 2, Note 3
12.75 GHz - 26 GHz	-47 dBm	1 MHz	Note 1, Note 2, Note 5

NOTE 1: *Measurement bandwidth*s as in ITU-R SM.329 [2], s4.1.
NOTE 2: Upper frequency as in ITU-R SM.329 [2], s2.5 table 1.
NOTE 3: Applies for Band for which the upper frequency edge of the UL *operating band* is greater than 2.55 GHz and less than or equal to 5.2 GHz.
NOTE 4: The frequency range from Δf_{OBUE} below the lowest frequency of the BS transmitter *operating band* to Δf_{OBUE} above the highest frequency of the BS transmitter *operating band* may be excluded from the requirement. Δf_{OBUE} is defined in clause 6.6.1. For *multi-band connectors*, the exclusion applies for all supported *operating band*s.
NOTE 5: Applies for Band for which the upper frequency edge of the UL *operating band* is greater than 5.2 GHz.

7.5.3 Minimum requirement for *BS type 1-C*

The RX spurious emissions requirements for *BS type 1-C* are that for each *antenna connector,* the power of emissions shall not exceed *basic limits* specified in table 7.6.2-1.

7.6 Receiver intermodulation

7.6.1 General

Third and higher order mixing of the two interfering RF signals can produce an interfering signal in the band of the desired channel. Intermodulation response rejection is a measure of the capability of the receiver to receive a wanted signal on its assigned channel frequency at the *antenna connector* for *BS type 1-C* in the presence of two interfering signals which have a specific frequency relationship to the wanted signal.

7.6.2 Minimum requirement for BS type 1-C

The MDR performance shall be [1%] of the reference measurement channel, with a wanted signal at the assigned channel frequency and two interfering signals coupled to the *BS type 1-C antenna connector*, with the conditions specified in tables 7.7.2-1 and 7.7.2-2 for narrowband intermodulation performance. The reference measurement channel for the wanted signal is identified in tables 7.2.2-1, 7.2.2-2 and 7.2.2-3 for each *BS channel bandwidth* and further specified in annex A.1. The characteristics of the interfering signal is further specified in annex D.

The receiver intermodulation requirement is applicable outside the *Base Station RF Bandwidth* or *Radio Bandwidth edges*. 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* within any *operating band*, the narrowband intermodulation requirement shall apply in addition inside any *sub-block gap* in case the *sub-block gap* is at least as wide as the *channel bandwidth* of the NR interfering signal in table 7.6.2-2 or 7.6.2-4. The interfering signal offset is defined relative to the *sub-block* edges inside the *sub-block gap*.

Table 7.6.2-1: Narrowband intermodulation performance requirement for A-IoT Medium Range BS

Channel bandwidth of the lowest/highest carrier received [kHz]	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering RB centre frequency offset from the lower/upper Base Station RF Bandwidth edge or sub-block edge inside a sub-block gap [kHz]	Type of interfering signal
200	$P_{REFSENS}$ + 6dB*	-53	±340	CW
		-53	±880	5MHz E-UTRA signal, 1 RB**
3520	$P_{REFSENS}$ + 6dB*	-53	±270	CW
		-53	±780	3.0 MHz E-UTRA signal, 1 RB**
Note*: $P_{REFSENS}$ depends on the sub-carrier spacing as specified in Table 7.2.2-1. Note**: Interfering signal consisting of one resource block positioned at the stated offset, the channel bandwidth of the interfering signal is located adjacently to the lower/upper Base Station RF Bandwidth edge.				

8 A-IoT CW transmitter characteristics

8.1 General

Unless otherwise stated, the transmitter characteristics are specified at the antenna connector of the CW node with a single or multiple transmit antenna(s). The CW waveform for D2R backscattering is a single-tone unmodulated sinusoid.

NOTE: CW transmission and A-IoT BS Downlink (DL) data transmission are non-concurrent. For FDD bands, the CW is transmitted in Uplink (UL) operating band.

8.2 CW Output power

8.2.1 General

Output power of the CW node is the mean power of the single-tone signal delivered to a load with resistance equal to the nominal load impedance of the transmitter.

Rated total output power (P_{rated}) of the CW node is the mean power of the single-tone signal that the manufacturer has declared to be available at the antenna connector during the transmitter ON period. The rated output power, $P_{rated,}$, of the CW node shall be less than or equal to +33 dBm.

Maximum output power (P_{max}) of the base station is the mean power level of the single-tone signal measured at the antenna connector during the transmitter ON period in a specified reference condition.

8.2.2 Minimum requirement

In normal conditions, the CW maximum output power, P_{max}, shall remain within +2 dB and -2 dB of the rated output power, P_{rated}, declared by the manufacturer.

In extreme conditions, the base station maximum output power, P_{max}, shall remain within +2.5 dB and -2.5 dB of the rated output power, P_{rated}, declared by the manufacturer.

In certain regions, the minimum requirement for normal conditions may apply also for some conditions outside the range of conditions defined as normal.

8.3 Frequency error

8.3.1 General

The requirements in clause 8.3 apply to the *transmitter ON period*.

Frequency error is the measure of the difference between the actual carrier wave transmit frequency and the assigned frequency. This requirement shall be applied at the *antenna connector* supporting transmission in the *operating band*.

8.3.2 Minimum requirement

The frequency of carrier wave measurements shall be accurate to within ± 0.1 ppm observed over a period of 1 ms compared to the carrier frequency declared by the manufacturer.

8.4 Transmit OFF power

8.4.1 General

Transmit OFF power is defined as the mean power when the transmitter is OFF.

8.4.2 Minimum requirement

The transmit OFF power shall not exceed -50 dBm/MHz

8.5 Unwanted emission

8.5.1 General

Unwanted emissions consist of phase noise, operating band unwanted emissions and spurious emissions.

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

8.5.2 Phase noise

8.5.2.1 General

The phase noise is the unwanted emissions outside the centre frequency of carrier wave resulting from random fluctuations in the phase of signal in the transmitter but excluding spurious emissions. The phase noise of the CW applies to ±7.5 kHz and ±120 kHz frequency offset (Δf) from centre frequency of carrier wave.

For the CW equipment declared capable of performing phase noise cancellation, the requirement in 8.5.2.2 is not applied.

8.5.2.2 Minimum requirement

The phase noise power of CW transmitter shall not exceed the levels specified in Table 8.5.2.2-1

Table 8.5.2.2-1: CW phase noise emission limit

Δf (kHz)	Phase noise emission limit (dBc/Hz)

± 7.5	-97
± 120	-102

8.5.3 Operating band unwanted emissions

8.5.3.1 General

Unless otherwise stated, the operating band unwanted emission (OBUE) limits in FR1 are defined from 10 MHz below the lowest frequency of each supported uplink *operating band* up to 10 MHz above the highest frequency of each supported uplink *operating band*.

Emissions shall not exceed the maximum levels specified in the tables below, where:

- Δf is the separation between the assigned transmission frequency and the nominal -3dB point of the measuring filter closest to the carrier frequency.

8.5.3.2 Minimum requirement

The operating band unwanted emissions shall not exceed the maximum levels specified in the Table 8.5.2.2-1. The spectrum emission limit between each Δf is linearly interpolated.

Table 8.5.3.2-1: CW node Operating band unwanted emissions

Δf (kHz)	Emission limit (dBm)	Measurement bandwidth
± 200	-18	30 kHz
± 250	-20	30 kHz
± 350	-25	30 kHz
± 800	-26	30 kHz
± 1200	-19	1 MHz
± 5200~10000	-23	1 MHz

8.5.4 Transmitter spurious emissions

8.5.4.1 General

The transmitter spurious emission limits shall apply from 9 kHz to 12.75 GHz, excluding the frequency range from 10MHz below the lowest frequency of each supported uplink *operating band*, up to 10 MHz above the highest frequency of each supported uplink *operating band*.

8.5.4.2 Minimum requirement

The power of any spurious emission shall not exceed the limits in Table 8.5.4.2-1.

Table 8.5.4.2-1: Spurious emissions limits

Frequency Range	Maximum Level	Measurement bandwidth
9 kHz ≤ f < 150 kHz	-36 dBm	1 kHz
150 kHz ≤ f < 30 MHz	-36 dBm	10 kHz
30 MHz ≤ f < 1000 MHz	-36 dBm	100 kHz
1 GHz ≤ f < 12.75 GHz	-30 dBm	1 MHz

Annex A (informative): D2R channel bandwidth

The following describes the equation to derive BS D2R channel bandwidth.

For BS D2R CBW:

D2R CBW for BS (kHz)

= ceiling ((2SB Transmission BW_without SFO× (1/2) +2× Small frequency shift_without SFO)/0.9)

=ceiling ((2+2R)/T_b × (1+ | SFO |)/0.9)

=ceiling ((1+R)/ (T_c ×R) × (1+ | SFO |)/0.9)

The 0.9 divisor presents the 90% BS filter spectrum utility (10% guard band).

Annex B (normative): Reference measurement channels

B.1 Fixed Reference Channels for reference sensitivity level, ACS, in-band blocking, out-of-band blocking, (BPSK, OOK)

Reference channel	A-FR1-A1-1	A-FR1-A1-2	A-FR1-A1-3	A-FR1-A1-4
DSB (kHz)	15	15	2880	2880
Payload size (bits)	96	96	96	96
CRC (bits)	16	16	16	16
Preamble length	31	31	31	31
Midamble length	31	31	31	31
Midamble configuration I	48	48	48	48
FEC	1/3	1/3	1/3	1/3
Line code	Manchester	Manchester	Manchester	Manchester
Modulation	BPSK	OOK	BPSK	OOK
Waveform (CW)	unmodulated single tone	Unmodulated single tone	unmodulated single tone	unmodulated single tone
Sampling frequency （SFO）	between 0.01 and 0.1	Between 0.01 and 0.1	between 0.01 and 0.1	Between 0.01 and 0.1
Total symbols	398	398	398	398

Annex C (normative): Characteristics of the interfering signals

The interfering signal shall be a PUSCH containing data and DM-RS symbols. Normal cyclic prefix is used. The data content shall be uncorrelated to the wanted signal and modulated according to clause 6 of TS38.211 [5]. Mapping of PUSCH modulation to receiver requirement are specified in table C-1.

Table C-1: Modulation of the interfering signal

Receiver requirement	Modulation
Adjacent channel selectivity	QPSK
General blocking	QPSK
Receiver intermodulation	QPSK

Annex D (Informative): Change history

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2025-04	RAN4#114 bis	R4-2505228				3GPP_TS 38.194 skeleton	0.0.1
2025-08	RAN4#116	R4-2511749				Agreed TP in RAN4#116: R4-2511722 TP for TR 38.194 5.3 BS channel bandwidth and 5.4 Channel arrangement R4-2511723 TP for TR 38.191 section 3 Definitions, symbols and abbreviations R4-2511725 draft TP for TS 38.194 to introduce base station output power and transmit ON/OFF power R4-2511727 TP for TR 38.194 6.5 Unwanted emissions and 6.6 Transmitter intermodulation R4-2511728 draft TP to TS 38.194 on Transmitted signal quality R4-2511731 TP to TS38.194: REFSENS requirement for A-IoT BS and FRC R4-2511732 TP to TS38.194 : ACS , Inband blocking, OOB and Spurious R4-2511742 TP to TS 38.194 on CW frequency error and unwanted emssion R4-2511743 TP to 38.194 on general and CW output power	0.0.2
2025-09	RAN#109	RP-252745					1.0.0

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2025-09	RAN#109					Approved by plenary – Rel-19 spec under change control	19.0.0
2025-12	RAN#110	RP-253654	0003		F	CR for TS 38.194, Correction on A-IoT BS Annex	19.1.0
2025-12	RAN#110	RP-253844	0006	4	B	CR for TS 38.194 on including n5 and n28 for A-IoT [Ambient_IoT_n5_n28]	19.1.0
2025-12	RAN#110	RP-253654	0004	1	F	CR for TS 38.194, Correction on A-IoT BS requirements. Note: CR was not implemented due to massive CR clashes of R4-2522325 and R4-2523216 in RP-253654.	19.1.0
2025-12	RAN#110	RP-253654	0005	3	F	CR for TS 38.194 on A-IoT BS RF requirements Note: CR was not implemented due to massive CR clashes of R4-2522325 and R4-2523216 in RP-253654.	19.1.0

History

Version	Date	Status
V19.0.0	October 2025	Publication
V19.1.0	February 2026	Publication