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Contents

Foreword

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

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2 presented to TSG for approval;

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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.

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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

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

can indicates that something is possible

cannot indicates that something is impossible

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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 specifies the Radio Frequency (RF) test methods and conformance requirements for Ambient IoT Base Station (BS) and Carrier-Wave (CW) node. These have been derived from, and are consistent with the conducted requirements in specification defined in TS 38.194 [3].

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

[3] 3GPP TS 38.194: "NR Ambient IoT Base Station (BS) and Carrier-Wave (CW) node radio transmission and reception".

[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 25.104: "Base Station (BS) radio transmission and reception (FDD)".

[6] 3GPP TS 36.104: "Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception".

[7] 3GPP TS 38.104: "NR; Base Station (BS) radio transmission and reception".

3 Definitions of terms, symbols and abbreviations

3.1 Terms

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

channel edge: lowest or highest frequency of the A-IoT carrier, separated by the *BS channel bandwidth*

maximum carrier output power: mean power level measured per carrier at the indicted 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 A-IoT 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 TS 38.194 [3], tables 5.1-1.

Radio Bandwidth: frequency difference between the upper edge of the highest used carrier and the lower edge of the lowest used carrier

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

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

requirement set:one of the A-IoT base station requirement's set as defined for *BS type 1-C*

single-band connector: *antenna connector* of the *BS type 1-C* supporting operation either in a single *operating band* only

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:

β	Percentage of the mean transmitted power emitted outside the occupied bandwidth on the assigned channel
$BW_{Channel}$	*BS channel bandwidth*
BW_{Config}	Transmission bandwidth configuration, expressed in MHz, where $BW_{Config} = N_{RB}$ x SCS x 12 kHz
Δf	Separation between the channel edge frequency and the nominal -3 dB point of the measuring filter closest to the carrier frequency
Δf_{max}	f_offset_{max} minus half of the bandwidth of the measuring filter
ΔF_{Global}	Global frequency raster granularity
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
F_{offset_high} Frequency offset from F_{C_high} to the upper *Base Station RF Bandwidth edge*, or from $F_{C,block,\ high}$ to the upper sub-block edge
F_{offset_low} Frequency offset from F_{C_low} to the lower *Base Station RF Bandwidth edge*, or from $F_{C,block,\ low}$ to the lower sub-block edge
F_{DL_low} The lowest frequency of the downlink *operating band*
F_{DL_high} The highest frequency of the downlink *operating band*
F_{filter} Filter centre frequency
F_{offset} Frequency offset from F_{C_high} to the upper Base Station RF Bandwidth edge, or F_{C_low} to the lower Base Station RF Bandwidth edge.
f_offset Separation between the channel edge frequency and the centre of the measuring filter
f_offset_{max} The offset to the frequency Δf_{OBUE} outside the downlink *operating band*
F_{REF} RF reference frequency
F_{DL_low} The lowest frequency of the downlink *operating band*
F_{DL_high} The highest frequency of the downlink *operating band*
F_{UL_low} The lowest frequency of the uplink *operating band*
F_{UL_high} The highest frequency of the uplink *operating band*
$GB_{Channel}$ Minimum guard band defined in TS 38.194 [3] clause 5.3.1.3
Iuant gNB internal logical interface between the implementation specific O&M function and the RET antennas and TMAs control unit function of the gNB
N_{RB} Transmission bandwidth configuration, expressed in resource blocks
N_{REF} NR Absolute Radio Frequency Channel Number (NR-ARFCN)
$P_{max,c,AC}$ *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].

ACLR Adjacent Channel Leakage Ratio
ACS Adjacent Channel Selectivity
AWGN Additive White Gaussian Noise
BS Base Station
BW Bandwidth
CP-OFDM Cyclic Prefix-OFDM
CW Continuous Wave
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
GSCN Global Synchronization Channel Number
ITU-R Radiocommunication Sector of the International Telecommunication Union
LNA Low Noise Amplifier
MR Medium Range
NR-ARFCN NR Absolute Radio Frequency Channel Number
OBUE Operating Band Unwanted Emissions
R2D Reader to device
RB Resource Block
REFSENS Reference Sensitivity
RF Radio Frequency
RMS Root Mean Square (value)
RS Reference Signal
RX Receiver

SCS Sub-Carrier Spacing
TX Transmitter
TT Test Tolerance

4 General conducted test conditions and declarations

4.1 Measurement uncertainties and test requirements

4.1.1 General

The requirements of this clause apply to all applicable tests in this specification, i.e. to all conducted tests defined for FR1. The frequency ranges FR1 are defined in clause 5.1 of TS 38.194 [3].

The minimum requirements are given in TS 38.194 [3] and the references therein. Test Tolerances for the conducted test requirements explicitly stated in the present document are given in annex C of the present document.

Test Tolerances are individually calculated for each test. The Test Tolerances are used to relax the minimum requirements to create test requirements.

When a test requirement differs from the corresponding minimum requirement, then the Test Tolerance applied for the test is non-zero. The Test Tolerance for the test and the explanation of how the minimum requirement has been relaxed by the Test Tolerance are given in annex C.

4.1.2 Acceptable uncertainty of Test System

4.1.2.1 General

The maximum acceptable uncertainty of the Test System is specified below for each test defined explicitly in the present specification, where appropriate. The maximum acceptable uncertainty of the Test System for test requirements included by reference is defined in the respective referred test specification.

The Test System shall enable the stimulus signals in the test case to be adjusted to within the specified tolerance and the equipment under test to be measured with an uncertainty not exceeding the specified values. All tolerances and uncertainties are absolute values, and are valid for a confidence level of 95 %, unless otherwise stated.

A confidence level of 95 % is the measurement uncertainty tolerance interval for a specific measurement that contains 95 % of the performance of a population of test equipment.

For RF tests, it should be noted that the uncertainties in clause 4.1.2 apply to the Test System operating into a nominal 50 ohm load and do not include system effects due to mismatch between the DUT and the Test System.

4.1.2.2 Measurement of transmitter

Table 4.1.2.2-1: Maximum Test System uncertainty for transmitter tests

Clause	Maximum Test System Uncertainty	Derivation of Test System Uncertainty
6.2 Base Station output power 8.2 CW output power	±0.7 dB, f ≤ 3 GHz	
6.3.1 Transmit OFF power	±2.0 dB, f ≤ 3 GHz	
6.3.2 Transmitter transient period	N/A	
6.4.2 Frequency error 8.3 Frequency error	± 12 Hz	
6.4.3 Modulation quality	Modulation Depth: ±10% RF Envelope Ripple: ±1% RF Envelop Rise Time: ± 100 ns RF Envelop Fall Time: ± 100 ns RF Pulsewidth: ± 100 ns	
6.5.2 Occupied bandwidth	±2 kHz	

Clause	Maximum Test System Uncertainty	Derivation of Test System Uncertainty
6.5.3 Adjacent Channel Leakage power Ratio (ACLR)	ACLR: ±0.8 dB	
6.5.4 Operating band unwanted emissions 8.4.2 Operating band unwanted emissions	±1.5 dB, f ≤ 3 GHz	
6.5.5.5.1.1 Transmitter spurious emissions, Mandatory Requirements 8.4.3 Transmitter spurious emissions	9 kHz < f ≤ 4 GHz: ±2.0 dB 4 GHz < f ≤ 19 GHz: ±4.0 dB 19 GHz < f ≤ 26 GHz: ±4.5 dB	
6.5.5.5.1.2 Transmitter spurious emissions, Protection of BS receiver	±3.0 dB	
6.5.5.5.1.3 Transmitter spurious emissions, Additional spurious emission requirements	±2.0 dB for > -60 dBm, f ≤ 3 GHz ±2.5 dB, 3 GHz < f ≤ 4.2 GHz ±3.0 dB, 4.2 GHz < f ≤ 7.125 GHz (Note) ±3.0 dB for ≤ -60 dBm, f ≤ 3 GHz ±3.5 dB, 3 GHz < f ≤ 4.2 GHz ±4.0 dB, 4.2 GHz < f ≤ 7.125 GHz (Note)	
6.5.5.2.4 Transmitter spurious emissions, Co-location	±3.0 dB	
8.4.1 Phase noise	±4 dB	

4.1.2.3 Measurement of receiver

Table 4.1.2.3-1: Maximum Test System Uncertainty for receiver tests

Clause	Maximum Test System Uncertainty	Derivation of Test System Uncertainty
7.2 Reference sensitivity level	±0.7 dB, f ≤ 3 GHz	
7.3.1 Adjacent channel selectivity	±1.4 dB, f ≤ 3 GHz	Overall system uncertainty comprises three quantities: 1. Wanted signal level error 2. Interferer signal level error 3. Additional impact of interferer leakage Items 1 and 2 are assumed to be uncorrelated so can be root sum squared to provide the ratio error of the two signals. The interferer leakage effect is systematic, and is added arithmetically. Test System uncertainty = SQRT (wanted_level_error^2 + interferer_level_error^2) + leakage effect. f ≤ 3 GHz Wanted signal level ±0.7 dB Interferer signal level ±0.7 dB
7.3.2.4.2 In-band blocking (General blocking)	±1.6 dB, f ≤ 3 GHz	
7.4.5.1 Out-of-band blocking (General requirements)	f_{wanted} ≤ 3GHz 1MHz < $f_{interferer}$ ≤ 3 GHz: ±1.3 dB 3.0GHz < $f_{interferer}$ ≤ 4.2 GHz: ±1.5 dB 4.2GHz < $f_{interferer}$ ≤ 12.75 GHz: ±3.2 dB	Overall system uncertainty comprises three quantities: 1. Wanted signal level error 2. Interferer signal level error 3. Interferer broadband noise Items 1 and 2 are assumed to be uncorrelated so can be root sum squared to provide the ratio error of the two signals. The Interferer Broadband noise effect is systematic, and is added arithmetically. Test System uncertainty = SQRT (wanted_level_error^2 + interferer_level_error^2) + Broadband noise effect. Out of band blocking, using CW interferer: Wanted signal level: ±0.7 dB up to 3 GHz Interferer signal level: ±1.0 dB up to 3 GHz ±1.2 dB up to 4.2 GHz ±3.0 dB up to 12.75 GHz Impact of interferer Broadband noise 0.1 dB
7.4.5.2 Out-of-band blocking (Co-location requirements)	Co-location blocking, using CW interferer: ±2.5 dB, f ≤ 3.0 GHz	Co-location blocking, using CW interferer: f ≤ 3.0 GHz Wanted signal level ± 0.7 dB f ≤ 7.125 GHz Interferer signal level: ± 2.0 dB Interferer ACLR not applicable Impact of interferer Broadband noise 0.4 dB
7.5 Receiver spurious emissions	30 MHz ≤ f ≤ 4 GHz: ±2.0 dB 4 GHz < f ≤ 19 GHz: ±4.0 dB 19 GHz < f ≤ 26 GHz: ±4.5 dB	

7.6 Receiver intermodulation	±1.8 dB, f ≤ 3.0 GHz	Overall system uncertainty comprises four quantities: 1. Wanted signal level error 2. CW Interferer level error 3. Modulated Interferer level error 4. Impact of interferer ACLR The effect of the closer CW signal has twice the effect. Items 1, 2 and 3 are assumed to be uncorrelated so can be root sum squared to provide the combined effect of the three signals. The interferer ACLR effect is systematic, and is added arithmetically. Test System uncertainty = SQRT [(2 x CW_level_error)^2 +(mod interferer_level_error)^2 +(wanted signal_level_error)^2] + ACLR effect. f ≤ 3.0 GHz Wanted signal level ± 0.7dB CW interferer level ± 0.5 dB Mod interferer level ± 0.7 dB
NOTE: Unless otherwise noted, only the Test System stimulus error is considered here. The effect of errors in the throughput measurements due to finite test duration is not considered.		

4.1.3 Interpretation of measurement results

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].

The actual measurement uncertainty of the Test System for the measurement of each parameter shall be included in the test report.

The recorded value for the Test System uncertainty shall be, for each measurement, equal to or lower than the appropriate figure in clause 4.1.2 of the present document.

If the Test System for a test is known to have a measurement uncertainty greater than that specified in clause 4.1.2, it is still permitted to use this apparatus provided that an adjustment is made as follows.

Any additional uncertainty in the Test System over and above that specified in clause 4.1.2 shall be used to tighten the test requirement, making the test harder to pass. For some tests e.g. receiver tests, this may require modification of stimulus signals. This procedure will ensure that a Test System not compliant with clause 4.1.2 does not increase the chance of passing a device under test where that device would otherwise have failed the test if a Test System compliant with clause 4.1.2 had been used.

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.

Table 4.2-1 lists all requirements in the present specification that may be applied differently in different regions.

Table 4.2-1: List of regional requirements

Clause number	Requirement	Comments
5	Operating bands	Some A-IoT operating bands may be applied regionally.
6.2.1	Base station output power	Additional output power limits may be applied regionally.
6.5.2	Occupied bandwidth	The requirement may be applied regionally. There may also be regional requirements to declare the occupied bandwidth according to the definition in present specification.
6.5.3.5.3	Adjacent Channel Leakage Power Ratio	For Band n41 and n90 operation in Japan, absolute ACLR limits shall be applied to the sum of the absolute ACLR power over all *antenna connectors* for *BS type 1-C*.
6.5.4.5	Operating band unwanted emission	Category A or Category B operating band unwanted emission limits may be applied regionally. For operation with shared spectrum channel access, the BS may have to comply with the applicable BS power limits established regionally, when deployed in regions where those limits apply and under the conditions declared by the manufacturer.
6.5.4.5.6.1	Operating band unwanted emissions: Limits in FCC Title 47	The BS may have to comply with the additional requirements, when deployed in regions where those limits are applied, and under the conditions declared by the manufacturer.
6.5.4.5.6.2	Operating band unwanted emission Protection of DTT	The BS operating in Band n20 may have to comply with the additional requirements for protection of DTT, when deployed in certain regions.
6.5.4.5.7	Operating band unwanted emission,	For Band n41 and n90 operation in Japan, the operating band unwanted emissions limits shall be applied to the sum of the emission power over all *antenna connectors* for *BS type 1-C*.
6.5.5.5.1.1	Transmitter spurious emissions	Category A or Category B spurious emission limits, as defined in ITU-R Recommendation SM.329 [2], may apply regionally. The emission limits for BS type 1-H specified as the *basic limit* + X (dB) are applicable, unless stated differently in regional regulation. In addition, for operation with shared spectrum channel access, the BS may have to comply with the applicable spurious emission limits established regionally, when deployed in regions where those limits apply and under the conditions declared by the manufacturer.
6.5.5.5.1.3	Transmitter spurious emissions: additional requirements	These requirements may be applied for the protection of system operating in frequency ranges other than the BS operating band.
6.5.5.5.3	Transmitter spurious emissions	For Band n41 and n90 operation in Japan, the sum of the spurious emissions over all *antenna connectors* for *BS type 1-C* shall not exceed the *basic limits*.
7.5.5.2, 7.5.5.3	Receiver spurious emissions	The emission limits for BS type 1-H specified as the *basic limit* + X (dB) are applicable, unless stated differently in regional regulation. For Band n41 and n90 operation in Japan, the sum of RX spurious emissions over all *antenna connectors* for *BS type 1-C* shall not exceed *basic limits*

4.3 BS configurations

4.3.1 BS type 1-C

4.3.1.1 Transmit configurations

4.3.1.1.1 General

Unless otherwise stated, the transmitter characteristics in clause 6 are specified at the BS antenna connector (test port A) with a full complement of transceivers for the configuration in normal operating conditions. If any external apparatus such as a TX amplifier, a filter or the combination of such devices is used, requirements apply at the far end antenna connector (test port B).

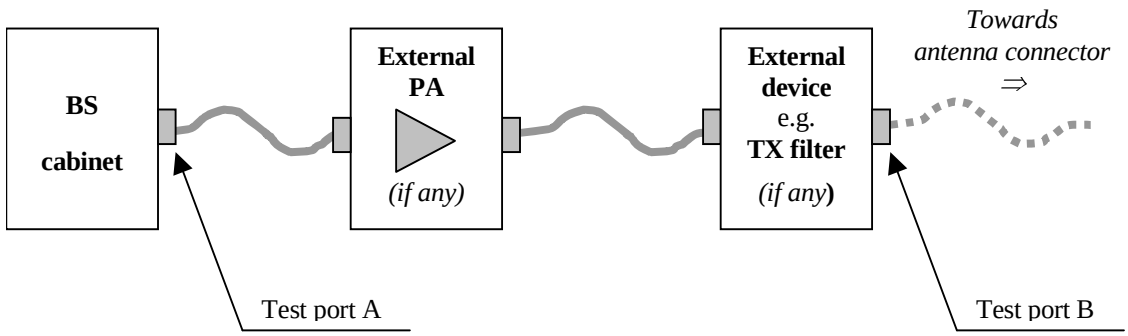

Figure 4.3.1.1.1-1: Transmitter test ports

4.3.1.1.2 Transmission with multiple transmitter antenna connectors

Unless otherwise stated, for the tests in clause 6 of the present document, the requirement applies for each transmitter *antenna connector* in the case of transmission with multiple transmitter *antenna connectors*.

Transmitter requirements are tested at the *antenna connector*, with the remaining *antenna connector(s)* being terminated. If the manufacturer has declared the transmitter paths to be equivalent (D.32), it is sufficient to measure the signal at any one of the transmitter *antenna connectors*.

4.3.1.2 Receive configurations

4.3.1.2.1 General

Unless otherwise stated, the receiver characteristics in clause 7 are specified at the BS *antenna connector* (test port A) with a full complement of transceivers for the configuration in normal operating conditions. If any external apparatus such as a RX amplifier, a filter or the combination of such devices is used, requirements apply at the far end *antenna connector* (test port B).

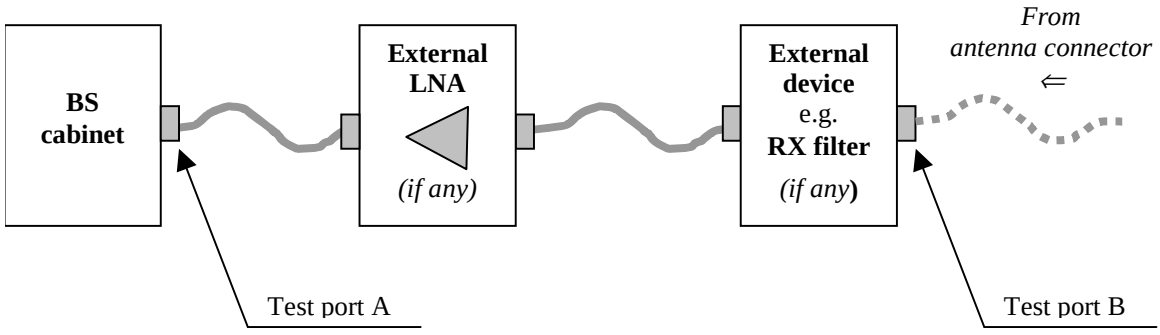

Figure 4.3.1.2.1-1: Receiver test ports

4.3.1.2.2 Reception with multiple receiver antenna connectors, receiver diversity

For the tests in clause 7 of the present document, the requirement applies at each receiver *antenna connector* for receivers with antenna diversity or in the case of multi-carrier reception with multiple receiver *antenna connectors*.

Receiver requirements are tested at the *antenna connector*, with the remaining receiver(s) disabled or their *antenna connector(s)* being terminated. If the manufacturer has declared the receiver paths to be equivalent (D.32), it is sufficient to apply the specified test signal at any one of the receiver *antenna connectors*.

For a *BS type 1-C* supporting multi-band operation, multi-band tests for ACS, blocking and intermodulation are performed with the interferer(s) applied to each *antenna connector* mapped to the receiver for the wanted signal(s), however only to one *antenna connector* at a time. *Antenna connectors* to which no signals are applied are terminated.

4.3.1.3 Duplexers

The requirements of the present document shall be met with a duplexer fitted, if a duplexer is supplied as part of the BS. If the duplexer is supplied as an option by the manufacturer, sufficient tests should be repeated with and without the duplexer fitted to verify that the BS meets the requirements of the present document in both cases.

The following tests shall be performed with the duplexer fitted, and without it fitted if this is an option:

1) clause 6.2, base station output power, for the highest static power step only, if this is measured at the antenna connector;

2) clause 6.6, unwanted emissions; outside the BS transmit band;

3) clause 6.6.5.5.1.2, protection of the BS receiver;

4) clause 6.7, transmit intermodulation; for the testing of conformance, the carrier frequencies should be selected to minimize intermodulation products from the transmitters falling in receive channels.

The remaining tests may be performed with or without the duplexer fitted.

NOTE 1: When performing receiver tests with a duplexer fitted, it is important to ensure that the output from the transmitters does not affect the test apparatus. This can be achieved using a combination of attenuators, isolators and filters.

NOTE 2: When duplexers are used, intermodulation products will be generated, not only in the duplexer but also in the antenna system. The intermodulation products generated in the antenna system are not controlled by 3GPP specifications, and may degrade during operation (e.g. due to moisture ingress). Therefore, to ensure continued satisfactory operation of a BS, an operator will normally select NR-ARFCNs to minimize intermodulation products falling on receive channels. For testing of complete conformance, an operator may specify the NR-ARFCNs to be used.

4.3.1.4 Power supply options

If the BS is supplied with a number of different power supply configurations, it may not be necessary to test RF parameters for each of the power supply options, provided that it can be demonstrated that the range of conditions over which the equipment is tested is at least as great as the range of conditions due to any of the power supply configurations.

This applies particularly if a BS contains a DC rail which can be supplied either externally or from an internal mains power supply. In this case, the conditions of extreme power supply for the mains power supply options can be tested by testing only the external DC supply option. The range of DC input voltages for the test should be sufficient to verify the performance with any of the power supplies, over its range of operating conditions within the BS, including variation of mains input voltage, temperature and output current.

4.3.1.5 Ancillary RF amplifiers

The *BS type 1-C* requirements of the present document shall be met with the ancillary RF amplifier fitted. At tests according to clauses 6 and 7 for TX and RX respectively, the ancillary amplifier is connected to the BS by a connecting network (including any cable(s), attenuator(s), etc.) with applicable loss to make sure the appropriate operating conditions of the ancillary amplifier and the BS. The applicable connecting network loss range is declared by the manufacturer (D.35). Other characteristics and the temperature dependence of the attenuation of the connecting network are neglected. The actual attenuation value of the connecting network is chosen for each test as one of the applicable extreme values. The lowest value is used unless otherwise stated.

Sufficient tests should be repeated with the ancillary amplifier fitted and, if it is optional, without the ancillary RF amplifier to verify that the BS meets the requirements of the present document in both cases.

When testing, the following tests shall be repeated with the optional ancillary amplifier fitted according to the table below, where "x" denotes that the test is applicable:

Table 4.3.1.5-1: Tests applicable to ancillary RF amplifiers

	Clause	TX amplifier only	RX amplifier only	TX/RX amplifiers combined (Note 1, 2)
Receiver tests	7.2		x	x
	7.4		x	x
	7.5		x	x
	7.6		x	
Transmitter tests	6.2	x		x
	6.5.2	x		x
	6.5.3	x		x
	6.5.4	x		x
	6.5.5	x		x
NOTE 1: Combining can be by duplex filters or any other network. The amplifiers can either be in RX or TX branch or in both. Either one of these amplifiers could be a passive network. NOTE 2: Unless otherwise stated, BS with both TX and RX amplifiers are tested once with both amplifiers active for each test.				

In base station output power test (clause 6.2) and reference sensitivity level test (clause 7.2) highest applicable attenuation value is applied.

4.4 Manufacturer declarations

The following BS declarations listed in table 4.4-1, when applicable to the BS under test, are required to be provided by the manufacturer for the conducted requirements testing of the *BS type 1-C*.

Table 4.4-1 Manufacturer declarations for *BS type 1-C* conducted test requirements

Declaration identifier	Declaration	Description	*BS type 1-C*
D.1	BS requirements set	Declaration of one of the A-IoT base station *requirement's set* as defined for *BS type 1-C*.	x
D.3	*Operating bands* and frequency ranges	List of A-IoT *operating band(s)* supported by *single-band connector(s)* and/or *multi-band connector(s)* of the BS and if applicable, frequency range(s) within the *operating band(s)* that the BS can operate in. Declarations shall be made per *antenna connector* for *BS type 1-C*.	x
D.4	Spurious emission category	Declare the BS spurious emission category as either category A or B with respect to the limits for spurious emissions, as defined in Recommendation ITU-R SM.329 [2].	x
D.5	Additional operating band unwanted emissions	The manufacturer shall declare whether the BS under test is intended to operate in geographic areas where the additional operating band unwanted emission limits defined in clause 6.6.4.5.6 apply.	x
D.6	Co-existence with other systems	The manufacturer shall declare whether the BS under test is intended to operate in geographic areas where one or more of the systems GSM850, GSM900, DCS1800, PCS1900, UTRA FDD, UTRA TDD, E-UTRA, PHS and/or NR operating in another band are deployed.	x
D.7	Co-location with other base stations	The manufacturer shall declare whether the BS under test is intended to operate co-located with Base Stations of one or more of the systems GSM850, GSM900, DCS1800, PCS1900, UTRA FDD, UTRA TDD, E-UTRA and/or NR operating in another band.	x
D.11	Maximum *Base Station RF Bandwidth*	Maximum *Base Station RF Bandwidth* in the *operating band* for single-band operation. Declared per supported *operating band,* per *antenna connector* for *BS type 1-C.*	x
D.14	A-IoT supported channel bandwidths and SCS	A-IoT supported SCS and channel bandwidths per supported SCS. Declared per supported *operating band,* per *antenna connector* for *BS type 1-C.*	x
D.21	Rated carrier output power ($P_{rated,c,AC}$)	Conducted rated carrier output power, per *single band connector.* Declared per supported *operating band*, per *antenna connector* for *BS type 1-C*.	x
D.22	R*ated total output power* ($P_{rated,t,AC}$)	Conducted total rated output power*.* Declared per supported *operating band*, per *antenna connector* for *BS type 1-C.*	x
D.32	Equivalent connectors	List of *antenna connectors* of *BS type 1-C*, which have been declared equivalent. Equivalent connectors imply that the *antenna connector* of *BS type 1-C*, are expected to behave in the same way when presented with identical signals under the same operating conditions. All declarations made for the *antenna connector* of *BS type 1-C*, are identical and the transmitter unit and/or receiver unit driving the *antenna connector* of *BS type 1-C* are of identical design.	x
D.35	Connecting network loss range for BS testing with ancillary RF amplifiers	Declaration of the range of connecting network losses (in dB) for *BS type 1-C* testing with ancillary Tx RF amplifier only, or with Rx RF amplifier only, or with combined Tx/Rx RF amplifiers.	x
NOTE: This manufacturer may declare two values, one with a minimum of +6dB and the other with a minimum of +3dB.			

4.5 Test configurations

4.5.1 General

The test configurations shall be constructed using the methods defined below, subject to the parameters declared by the manufacturer for the supported RF configurations as listed in clause 4.6. The test configurations to use for conformance testing are defined for each supported RF configuration in clauses 4.8.3 and 4.8.4.

The applicable test models for generation of the carrier transmit test signal are defined in clause 4.9.

NOTE: If required, carriers are shifted to align with the channel raster.

4.5.2 Test signal used to build Test Configurations

The signal's channel bandwidth and subcarrier spacing used to build A-IoT Test Configurations shall be selected according to table 4.5.2-1.

Table 4.5.2-1: Signal to be used to build A-IoT TCs

TC signal	R2D channel $BW_{channel}$	200kHz (Note)	400kHz (Note)	600 kHz (Note)	800 kHz (Note)
characteristics	Subcarrier spacing	15kHz			
NOTE: If this channel bandwidth is not supported, the narrowest supported channel bandwidth shall be used.					

A-IoT support only single carrier operation.

4.6 Applicability of requirements

4.6.1 General

4.6.2 Requirement set applicability

In table 4.6.2-1, the requirement applicability for each requirement set is defined. For each requirement, the applicable requirement clause in the specification is identified.

Table 4.6.2-1: Requirement set applicability

Requirement	BS type 1-C
BS output power	6.2
Transmit ON/OFF power	6.3
Transmitted signal quality	6.4
Occupied bandwidth	6.5.2
ACLR	6.5.3.5.3
Operating band unwanted emissions	6.5.4.5.7
Transmitter spurious emissions	6.5.5.5.3
Reference sensitivity level	7.2
In-band selectivity and blocking	7.3
Out-of-band blocking	7.4
Receiver spurious emissions	7.5.5.2
Receiver intermodulation	7.6
Performance requirements	9

4.6.3 Applicability of test configurations for single-band operation

The applicable test configurations are specified in the tables below for each the supported RF configuration, which shall be declared according to clause 4.6. The generation and power allocation for each test configuration is defined in clause 4.7. This clause contains the test configurations for a BS capable of single carrier, in single band.

For a BS declared to be capable of single carrier operation only (D.16), a single carrier (SC) shall be used for testing.

Unless otherwise stated, single carrier configuration (SC) tests shall be performed using signal with narrowest supported channel bandwidth and the smallest supported sub-carrier spacing.

4.7 RF channels and test models

4.7.1 RF channels

For the single carrier testing many tests in this TS are performed with appropriate frequencies in the bottom, middle and top channels of the supported frequency range of the BS. These are denoted as RF channels B (bottom), M (middle) and T (top).

Unless otherwise stated, the test shall be performed with a single carrier at each of the RF channels B, M and T.

Many tests in this TS are performed with the maximum Base Station RF Bandwidth located at the bottom, middle and top of the supported frequency range in the operating band. These are denoted as B_{RFBW} (bottom), M_{RFBW} (middle) and T_{RFBW} (top).

Unless otherwise stated, the test shall be performed at B_{RFBW}, M_{RFBW} and T_{RFBW} defined as following:

- B_{RFBW}: maximum Base Station RF Bandwidth located at the bottom of the supported frequency range in the operating band.
- M_{RFBW}: maximum Base Station RF Bandwidth located in the middle of the supported frequency range in the operating band.
- T_{RFBW}: maximum Base Station RF Bandwidth located at the top of the supported frequency range in the operating band.

When a test is performed by a test laboratory, the position of B, M and T for single carrier, B_{RFBW}, M_{RFBW} and T_{RFBW} for single band operation in each supported operating band. The laboratory may consult with operators, the manufacturer or other bodies.

4.7.2 Test models

4.7.2.1 General

The following clauses will describe the A-IoT test models needed for *BS type 1-C*.

4.7.2.2 FR1 test models

4.7.2.2.1 General

The set-up of physical channels for transmitter tests shall be according to one of the A-IoT test models (A-TM) below. A reference to the applicable test model is made within each test.

The following general parameters are used by all A-IoT test models:

- Duration is 1 radio frame (10 ms) for FDD
- The slots are numbered 0 to $10\times2^{\mu} - 1$ where μ is the numerology corresponding to the subcarrier spacing
- N_{RB} is the maximum transmission bandwidth configuration seen in table 5.3.2-1 in TS 38.194 [3].

- Normal CP
- Virtual resource blocks of localized type

4.7.2.2.2 A-IoT test model 1.1 (A-TM1.1)

This model shall be used for tests on:

- BS output power
- Transmit ON/OFF power
- Unwanted emissions
  - Occupied bandwidth
  - ACLR
  - Operating band unwanted emissions
  - Transmitter spurious emissions
- Transmitter intermodulation
- Receiver spurious emissions

Common physical channel parameters are defined in clause 4.7.2.2. Specific physical channel parameters for A-TM1.1 are defined in table 4.7.2.2.2-1.

Table 4.7.2.2.2-1: Specific physical channel parameters of A-TM1.1

Parameter	Value
# of PRBs PRDCH $n_{\mathrm{RNTI}} = 0$	N_{RB} - 3
Modulation PRDCH $n_{\mathrm{RNTI}} = 0$	OOK-4
Starting RB location of PRDCH $n_{\mathrm{RNTI}} = 0$	3
Modulation of PRDCH $n_{\mathrm{RNTI}} = 2$	OOK-4
Starting RB location of PRDCH $n_{\mathrm{RNTI}} = 2$	0

4.8 Format and interpretation of tests

Each test has a standard format:

X Title

All tests are applicable to all equipment within the scope of the present document, unless otherwise stated.

X.1 Definition and applicability

This clause gives the general definition of the parameter under consideration and specifies whether the test is applicable to all equipment or only to a certain subset. Required manufacturer declarations may be included here.

X.2 Minimum requirement

This clause contains the reference to the clause to the 3GPP reference (or core) specification which defines the minimum requirement.

X.3 Test purpose

This clause defines the purpose of the test.

X.4 Method of test

X.4.1 General

In some cases there are alternative test procedures or initial conditions. In such cases, guidance for which initial conditions and test procedures can be applied are stated here. In the case only one test procedure is applicable, that is stated here.

X.4.2y First test method

X.4.2y.1 Initial conditions

This clause defines the initial conditions for each test, including the test environment, the RF channels to be tested and the basic measurement set-up.

X.4.2y.2 Procedure

This clause describes the steps necessary to perform the test and provides further details of the test definition like domain (e.g. frequency-span), range, weighting (e.g. bandwidth), and algorithms (e.g. averaging). The procedure may comprise data processing of the measurement result before comparison with the test requirement (e.g. average result from several measurement positions).

X.4.3y Alternative test method (if any)

If there are alternative test methods, each is described with its initial conditions and procedures.

X.5 Test requirement

This clause defines the pass/fail criteria for the equipment under test, see clause 4.1.3 (Interpretation of measurement results). Test requirements for every minimum requirement referred in clause X.2 are listed here. Cases where minimum requirements do not apply need not be mentioned.

5 Operating bands and channel arrangement

For the Ambient IoT operating bands specification, their channel bandwidth configurations, as well as channel raster specification, refer to TS 38.194 [3], clause 5 and its relevant clauses.

6 A-IoT BS transmitter characteristics

6.1 General

6.1.1 BS type 1-C

General test conditions for conducted transmitter tests are given in clause 4, including interpretation of measurement results and configurations for testing. BS configurations for the tests are defined in clause 4.5.

If a number of s*ingle-band connectors* have been declared equivalent (D.32), only a representative one is necessary to be tested to demonstrate conformance.

6.2 Base station output power

6.2.1 Definition and applicability

The conducted BS output power requirements are specified at *single-band connector*.

The *rated carrier output power* of the *BS type 1-C* shall be as specified in table 6.2.1-1.

Table 6.2.1-1: Rated carrier output power limits for BS type 1-C

BS class	$P_{rated,c,AC}$
Medium Range BS	≤ 38 dBm

The output power limit for the respective BS classes in tables 6.2.1.-1 shall be compared to the rated output power and the declared BS class. It is not subject to testing.

6.2.2 Minimum requirement

The minimum requirement applies per *single-band connector* supporting transmission in the *operating band*.

The minimum requirement for *BS type 1-C* is defined in TS 38.194 [3], clause 6.2.2.

6.2.3 Test purpose

The test purpose is to verify the accuracy of the *maximum carrier output power* across the frequency range and under normal and extreme conditions.

6.2.4 Method of test

6.2.4.1 Initial conditions

Test environment:

- Normal, see annex B.2,
- Extreme, see annexes B.3 and B.5.

RF channels to be tested for single carrier: B, M and T; see clause 4.7.1

Under extreme test environment, it is sufficient to test on one NR-ARFCN or one RF bandwidth position, and with one applicable test configuration defined in clauses 4.7 and 4.8. Testing shall be performed under extreme power supply conditions, as defined in Annex B.5.

NOTE: Tests under extreme power supply conditions also test extreme temperatures.

6.2.4.2 Procedure

1) Connect the power measuring equipment to *single-band connector(s)* under test as shown in annex D.1.1 for *BS type 1-C*. All connectors not under test shall be terminated.
2) For single carrier set the connector under test to transmit according to the applicable test configuration in clause 4.5 using the corresponding test models or set of physical channels in clause 4.7.2 at *rated carrier output power* $P_{rated,c,AC}$ for *BS type 1-C*.
3) Measure the *maximum carrier output power* ($P_{max,c,AC}$ for *BS type 1-C*) for each carrier at each connector under test.

6.2.5 Test requirement

For each *single-band connector* or *multi-band connector* under test, the power measured in clause 6.2.4.2 in step 3 shall remain within the values provided in table 6.2.5-1 for normal and extreme test environments, relative to the manufacturer's declared $P_{rated,c,AC}$ for *BS type 1-C*:

Table 6.2.5-1: Test requirement for conducted BS output power

	Normal test environment	Extreme test environment
BS type 1-C	f ≤ 3.0 GHz: ± 2.7 dB	f ≤ 3.0 GHz: ± 3.2 dB

6.3 Transmit ON/OFF power

6.3.1 Transmitter OFF power

6.3.1.1 Definition and applicability

Transmitter OFF power 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

The minimum requirement for *BS type 1-C* is in TS 38.194 [3], clause 6.3.1.2.

6.3.1.3 Test purpose

The purpose of this test is to verify the transmitter OFF power is within the limits of the minimum requirements.

6.3.1.4 Method of test

Requirement is tested together with transmitter transient period, as described in clause 6.3.2.4.

6.3.1.5 Test requirements

The conformance testing of transmit OFF power is included in the conformance testing of transmitter transient period; therefore, see clause 6.4.2.5 for test requirements.

6.3.2 Transmitter transient period

6.3.2.1 Definition and applicability

The *transmitter transient period* is the time period during which the transmitter unit is changing from the OFF period to the ON period or vice versa. The *transmitter transient period* is illustrated in figure 6.3.2.1-1.

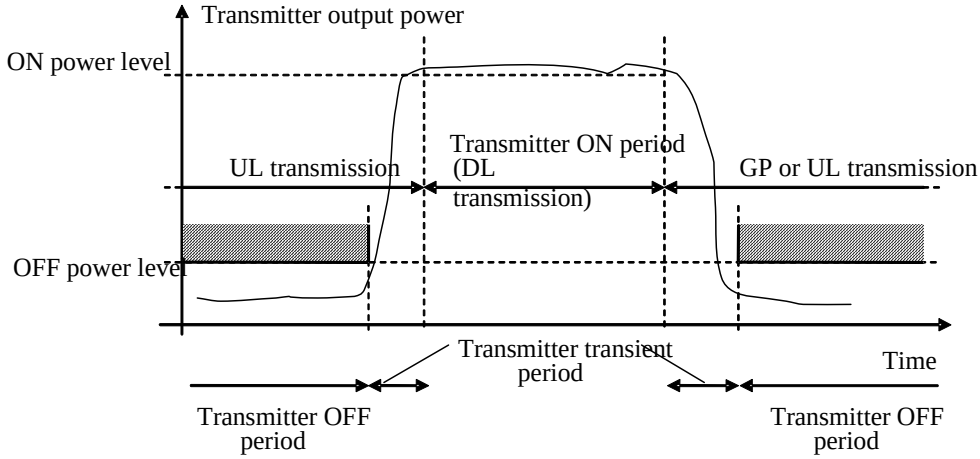

Figure 6.3.2.1-1: Illustration of the relations of transmitter ON period, transmitter OFF period and transmitter transient period

This requirement applies at each *antenna connector* supporting transmission in the operating band.

6.3.2.2 Minimum requirement

The minimum requirement for *BS type 1-C* is in TS 38.194 [3], clause 6.3.2.2.

6.3.2.3 Test purpose

The purpose of this test is to verify the transmitter transient periods are within the limits of the minimum requirements.

6.3.2.4 Method of test

6.3.2.4.1 Initial conditions

Test environment:

- normal; see annex B.2.

RF channels to be tested for single carrier:

- M; see clause 4.7.1.

6.3.2.4.2 Procedure

The minimum requirement is applied to all *antenna connectors*, they may be tested one at a time may be tested in parallel as shown in annex D.1.1 for *BS type 1-C*. Whichever method is used the procedure is repeated until all *antenna connectors* necessary to demonstrate conformance have been tested.

1) Connect *antenna connector* to measurement equipment as shown in annex D.1.1 for *BS type 1-C*. All *antenna connectors* not under test shall be terminated.

   As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity, efficiency and avoiding e.g. carrier leakage, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

2) For single carrier set the *antenna connector* under test to transmit according to the applicable test configuration in clause 4.5 using the corresponding test models or set of physical channels in clause 4.7.2 at manufacturers declared *rated carrier output power* per *antenna connector* ($P_{rated,c,AC}$).

3) Measure the mean power spectral density over 70/N μs filtered with a square filter of bandwidth equal to the RF bandwidth of the *antenna connector* centred on the central frequency of the RF bandwidth. 70/N μs average window centre is set from 35/N μs after end of one transmitter ON period + 10 μs to 35/N μs before start of next transmitter ON period – 10 μs. N = SCS/15, where SCS is Sub Carrier Spacing in kHz.

6.3.2.5 Test requirements

The measured mean power spectral density according to clause 6.3.2.4.2 shall be less than -83 dBm/MHz for carrier frequency $f \leq 3.0$ GHz.

6.4 Transmitted signal quality

6.4.1 General

Unless otherwise stated, the requirements in clause 6.5 apply during the *transmitter ON period*.

6.4.2 Frequency error

6.4.2.1 Definition and applicability

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.

It is not possible to verify by testing that the data clock is derived from the same frequency source as used for RF generation. This may be confirmed by the manufacturer's declaration.

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

6.4.2.2 Minimum Requirement

The minimum requirement is in TS 38.194 [3], clause 6.4.1.2.

6.4.2.3 Test purpose

The test purpose is to verify that frequency error is within the limit specified by the minimum requirement.

6.4.2.4 Method of test

Requirement is tested together with modulation quality test, as described in clause 6.4.3.

6.4.2.5 Test Requirements

The modulated carrier frequency of each A-IoT carrier configured by the BS shall be accurate to within the accuracy range given in table 6.4.2.5-1 observed over 1 ms.

Table 6.4.2.5-1: Frequency error test requirement

BS class	Accuracy
Medium Range BS	±(0.1 ppm + 12 Hz)

The frequency error requirement for A-IoT is specified in TS 38.194 [3] clause 6.4.1.2.

6.4.3 Modulation quality

6.4.3.1 Definition and applicability

Modulation quality include modulation depth, RF Envelop Rise Time, RF Envelop Fall Time, Ripple and pulsewidth of R2D signals.

Modulation depth is the measurement of the strength of variation imposed on a R2D carrier.

The Tr,10-90 RF Envelop Rise Time 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.

The Tf,10-90 RF Envelop Fall Time 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.

Ripple is the measurement of the non-ideal fluctuations in the amplitude of the R2D signal.

The Pulsewidth 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.

6.4.3.2 Minimum Requirement

The minimum requirement is in TS 38.194 [3], clause 6.4. 2.

6.4.3.3 Test purpose

The test purpose is to verify that R2D signal quality is within the limit specified by the minimum requirement across the frequency range and under normal and extreme conditions.

6.4.3.4 Method of test

6.4.3.4.0 General

Requirement is tested together with modulation quality test, as described in clause 6.4.3.

6.4.3.4.1 Initial conditions

Test environment:

- Normal, see annex B.2,
- Extreme, see annexes B.3 and B.5.

RF channels to be tested for single carrier: B, M and T; see clause 4.7.1

Under extreme test environment, it is sufficient to test on one NR-ARFCN or one RF bandwidth position, and with one applicable test configuration defined in clauses 4.7 and 4.8. Testing shall be performed under extreme power supply conditions, as defined in Annex B.5.

NOTE: Tests under extreme power supply conditions also test extreme temperatures.

6.4.3.4.2 Procedure

1. Transmit the test model A-TM 1.1 for modulation quality test.
   1) Connect the power measuring equipment to *single-band connector(s)* under test as shown in annex D.1.1 for *BS type 1-C.* All connectors not under test shall be terminated.
   2) For single carrier set the connector under test to transmit according to the applicable test configuration in clause 4.8 using the corresponding test models or set of physical channels in clause 4.9.2 at *rated carrier output power* $P_{rated,c,AC}$ for *BS type 1-C.*
2. Locate consecutive 3 chips with a pattern "1-0-1" within the pulse train of the transmitted signal. Denote the 3 chips as first chip, second chip and third chip. Make the below measurement according to description below:

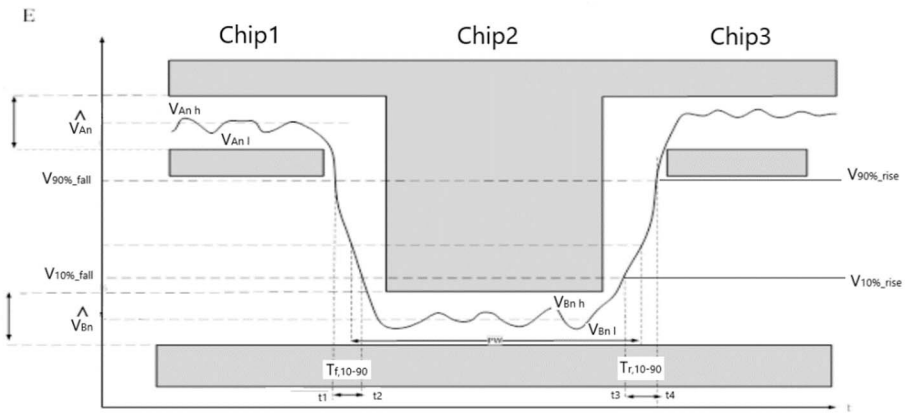

Figure 6.4.3.4.2-1:Timing mask for OOK Pulse

$\widehat{V_{An}}$: the average voltage measured over 1/2 duration above 90% V_{An_l} of the high level of first chip pulse;
$\widehat{V_{Bn}}$: the average voltage measured over 1/2 duration below 10% V_{An_l} of the low level of second chip pulse;
V_{An_h} : the highest instant voltage measured of the high level of first chip pulse over the same 1/2 duration of $\widehat{V_{An}}$ of the first chip pulse;
V_{An_l} : the lowest instant voltage measured of the high level of first chip pulse over the same 1/2 duration of $\widehat{V_{An}}$of the first chip pulse;
V_{Bn_h}: the highest instant voltage measured of the low level over the same 1/2 duration of $\widehat{V_{Bn}}$of the second chip pulse.
V_{Bn_l}: the lowest instant voltage measured of the low level over the same 1/2 duration of $\widehat{V_{Bn}}$ of the second chip pulse.

3. Mark the point in time as t1 on the selected pulse where the voltage starts to fall from high level of the first chip pulse to low level of second chip pulse at a voltage level below:

$$V_{90\%\_fall} = 90\% \cdot \left(\widehat{V_{An}} - \widehat{V_{Bn}}\right)$$

4. Mark the point in time t2 on the selected pulse where the voltage starts to fall from high level of first chip pulse to low level of second chip pulse at another voltage level below:

$$V_{10\%\_fall} = 10\% \cdot \left(\widehat{V_{An}} - \widehat{V_{Bn}}\right)$$

5. Mark the point in time as t3 on the second chip pulse where the voltage starts to rise from low level of second chip pulse to high level of third chip pulse at the voltage level $V_{10\%\_rise}$ below:

$$V_{10\%\_rise} = V_{10\%\_fall}$$

6. Mark the point in time t4 on the second chip pulse where the voltage starts to rise from low level of second chip pulse to high level of third chip pulse at the voltage level $V_{90\%\_rise}$ below:

$$V_{90\%\_rise} = V_{90\%\_fall}$$

7. Derive ripple measurement using formular below:

$$Ripple_{high}(\%) = \max\left(\frac{V_{An\_h} - \widehat{V_{An}}}{\widehat{V_{An}} - \widehat{V_{Bn}}}; \frac{V_{An\_l} - \widehat{V_{An}}}{\widehat{V_{An}} - \widehat{V_{Bn}}}\right) \cdot 100\%$$

$$Ripple_{low}(\%) = \max\left(\frac{V_{Bn\_h} - \widehat{V_{Bn}}}{\widehat{V_{An}} - \widehat{V_{Bn}}}; \frac{V_{Bn\_l} - \widehat{V_{Bn}}}{\widehat{V_{An}} - \widehat{V_{Bn}}}\right) \cdot 100\%$$

8. Derive the modulation depth measurement using formula below:

$$Modulation\ depth = \frac{\widehat{V_{An}} - \widehat{V_{Bn}}}{\widehat{V_{An}}}$$

9. Derive thee rising/fall time requirements using formular below:

$T_{f,10\text{-}90}$ = t2- t1

$T_{r,10\text{-}90}$ = t4- t3

10. Mark the time t5 at the voltage of $V_{50\%}$ where the voltage starts to fall from high level of first chip pulse to low level of second chip pulse and mark the time t6 where the voltage starts to rise from low level of second chip pulse to high level of third chip pulse. T

$$V_{50\%} = 50\% \cdot \left(\widehat{V_{An}} - \widehat{V_{Bn}}\right)$$

Derive time of the pulse time using formular below:

T_{pulse}= t6 -t5

11. Repeat the above measurement 10 times and derive the average value of the measurement
12. Compare the averaged measured result in step 10 to the requirement in clause 6.4.3.5.

6.4.3.5 Test requirements

The modulation quality of A-IoT R2D carrier shall be less than the limits in table 6.5.3.5-1.

The modulation depth, RF envelop ripple, RF envelop rise time and fall time, RF pulsewidth shall meet requirements in Figure 6.4.3.2-1.

Table 6.4.3.5-1: 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±10	%
	RF Envelope Ripple	Ripple_high Ripple_low	<=±15±1	%
	RF Envelop Rise Time	Tr,10-90	<=0.66Tc±0.1	μs
	RF Envelop Fall Time	Tf,10-90	<=0.66Tc±0.1	μs
	RF Pulsewidth	PW	<=1.3 Tc+0.1	μs

6.5 Unwanted emissions

6.5.1 General

Unwanted emissions consist of out-of-band emissions and spurious emissions according to ITU definitions in recommendation ITU-R SM.329 [2]. In ITU terminology, out of band emissions are unwanted emissions immediately outside the 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 Δf_{OBUE}. The operating band unwanted emissions define all unwanted emissions in each supported downlink *operating band* plus the frequency ranges Δf_{OBUE} above and Δf_{OBUE} below each band. Unwanted emissions outside of this frequency range are limited by a spurious emissions requirement.

The values of Δf_{OBUE} are defined in table 6.6.1-1 for the NR *operating bands.*

Table 6.5.1-1: Maximum offset of OBUE outside the downlink *operating band*

BS type	Operating band characteristics	Δf_{OBUE} (MHz)
BS type 1-C	$F_{DL\_high} - F_{DL\_low} \leq$ 200 MHz	10

6.5.2 Occupied bandwidth

6.5.2.1 Definition and applicability

The occupied bandwidth is the width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage β/2 of the total mean transmitted power. See also Recommendation ITU-R SM.328 [12].

The value of β/2 shall be taken as 0.5%.

The occupied bandwidth requirement shall apply during the *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 according to the definition in the present clause.

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 Requirements

The minimum requirement for *BS type 1-C* is in TS 38.194 [3] clause 6.6.2

6.5.2.3 Test purpose

The test purpose is to verify that the emission at the *antenna connector* does not occupy an excessive bandwidth for the service to be provided and is, therefore, not likely to create interference to other users of the spectrum beyond undue limits.

6.5.2.4 Method of test

6.5.2.4.1 Initial conditions

Test environment: Normal; see annex B.2.

RF channels to be tested for single carrier: M; see clause 4.7.1.

1) Connect the measurement device to the BS *antenna connector* as shown in annex D1.1 for *BS type 1-C*.

2) For a BS declared to be capable of single carrier operation (D.16), start transmission according to the applicable test configuration in clause 4.8 using the corresponding test model A-TM 1.1 at manufacturer's declared rated output power ($P_{rated,c,AC}$).

6.5.2.4.2 Procedure

1) Measure the spectrum emission of the transmitted signal using at least the number of measurement points, and across a span, as listed in table 6.6.2.4.2-1. The selected resolution bandwidth (RBW) filter of the analyser shall be 30 kHz or less.

Table 6.5.2.4.2-1: Span and number of measurement points for OBW measurements

Bandwidth	BS channel bandwidth $BW_{Channel}$ (kHz)			
	200	400	600	800
Span (kHz)	400	800	1200	1600
Minimum number of measurement points	4	8	12	16

NOTE: The detection mode of the spectrum analyzer will not have any effect on the result if the statistical properties of the out-of-OBW power are the same as those of the inside-OBW power. Both are expected to have the Rayleigh distribution of the amplitude of Gaussian noise. In any case where the statistics are not the same, though, the detection mode must be power responding. The analyser may be set to respond to the average of the power (root-mean-square of the voltage) across the measurement cell.

2) Compute the total of the power, P0, (in power units, not decibel units) of all the measurement cells in the measurement span. Compute P1, the power outside the occupied bandwidth on each side. P1 is half of the total power outside the bandwidth. P1 is half of (100 % - (occupied percentage)) of P0. For the occupied percentage of 99 %, P1 is 0.005 times P0.

3) Determine the lowest frequency, f1, for which the sum of all power in the measurement cells from the beginning of the span to f1 exceeds P1.

4) Determine the highest frequency, f2, for which the sum of all power in the measurement cells from f2 to the end of the span exceeds P1.

5) Compute the occupied bandwidth as f2 - f1.

6.5.2.5 Test requirements

The occupied bandwidth for each carrier shall be less than the channel bandwidth as defined in TS 38.194 [3], table 5.3.5-1 for *BS type 1-C*.

6.5.3 Adjacent Channel Leakage Power Ratio

6.5.3.1 Definition and applicability

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 applies during the *transmitter ON period*.

6.5.3.2 Minimum requirement

The minimum requirement applies per *single-band connector*, or per *multi-band connector* supporting transmission in the *operating band*.

The minimum requirement for *BS type 1-C* is defined in TS 38.194 [3], clause 6.6.3.3.

6.5.3.3 Test purpose

To verify that the adjacent channel leakage power ratio requirement shall be met as specified by the minimum requirement.

6.5.3.4 Method of test

6.5.3.4.1 Initial conditions

Test environment: Normal; see annex B.2.

RF channels to be tested for single carrier: B, M and T; see clause 4.7.1.

6.5.3.4.2 Procedure

1) Connect the *single-band connector* or *multi-band connector* under test to measurement equipment as shown in annex D.1.1 for *BS type 1-C*. All connectors not under test shall be terminated.

The measurement device characteristics shall be:

- Measurement filter bandwidth: defined in clause 6.6.3.5.
- Detection mode: true RMS voltage or true average power.

The emission power should be averaged over an appropriate time duration to ensure the measurement is within the measurement uncertainty in Table 4.1.2.2-1.

2) For a connectors declared to be capable of single carrier operation only (D.16), set the representative connectors under test to transmit according to the applicable test configuration in clause 4.8 using the corresponding test models [ ] in clause 4.9.2 at *rated carrier output power* $P_{rated,c,AC}$ for *BS type 1-C*.

3) Measure ACLR for the frequency offsets both side of channel frequency as specified in table 6.6.3.5.2-1.

4) Repeat the test with the channel set-up according to A-TM1.1 in clause 4.7.2.

6.5.3.5 Test requirements

6.5.3.5.1 General requirements

The ACLR requirements in clause 6.6.3.5.2 shall apply as described in clauses 6.6.3.5.3.

6.5.3.5.2 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.

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)	40.8dB
	500	A-IoT of same BW	Square (180 kHz)	45.8dB
400	500	A-IoT of same BW	Square (360 kHz)	40.8dB
	900	A-IoT of same BW	Square (360 kHz)	45.8dB
600	700	A-IoT of same BW	Square (540 kHz)	40.8dB
	1300	A-IoT of same BW	Square (540 kHz)	45.8dB
800	900	A-IoT of same BW	Square (720 kHz)	40.8dB
	1700	A-IoT of same BW	Square (720 kHz)	45.8dB

6.5.3.5.3 BS type 1-C

The ACLR test requirements for *BS type 1-C* are given in table 6.6.3.5.2-1 applies per *antenna connector*. Conformance can be shown by meeting the ACLR limit in table 6.6.3.5.2-1.

6.5.4 Operating band unwanted emissions

6.5.4.1 Definition and applicability

Unless otherwise stated, the operating band unwanted emission (OBUE) limits in FR1 are defined from Δf_{OBUE} below the lowest frequency of each supported downlink *operating band* up to Δf_{OBUE} above the highest frequency of each supported downlink *operating band*. The values of Δf_{OBUE} 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.

B*asic limits* are specified in the tables below, where:

- Δf is the separation between the channel edge frequency and the nominal -3 dB 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 Δf_{OBUE} outside the downlink *operating band*, where Δf_{OBUE} is defined in table 6.6.1-1.
- 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 6.6.4.5.4 shall apply (Category A and B).

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.

6.6.4.2 Minimum requirement

The minimum requirement applies per *single-band connector*, or per *multi-band connector* supporting transmission in the *operating band*.

The minimum requirement for *BS type 1-C* is defined in TS 38.194 [3], clause 6.6.4.3.

6.5.4.3 Test purpose

This test measures the emissions close to the assigned channel bandwidth of the wanted signal, while the transmitter is in operation.

6.5.4.4 Method of test

6.5.4.4.1 Initial conditions

Test environment: Normal; see annex B.2.

RF channels to be tested for single carrier: B, M and T; see clause 4.7.1.

- B_{RFBW}, M_{RFBW} and T_{RFBW} in single-band operation; see clause 4.7.1.

6.5.4.4.2 Procedure

1) Connect the *single-band connector* under test to measurement equipment as shown in annex D.1.1 for *BS type 1-C*. All connectors not under test shall be terminated.

   As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity, efficiency and avoiding e.g. carrier leakage, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

   The measurement device characteristics shall be:

   - Detection mode: True RMS.

   The emission power should be averaged over an appropriate time duration to ensure the measurement is within the measurement uncertainty in Table 4.1.2.2-1.

2) For a connectors declared to be capable of single carrier operation only, set the representative connectors under test to transmit according to the applicable test configuration in clause 4.5 at *rated carrier output power* $P_{rated,c,AC}$ for *BS type 1-C*. Channel set-up shall be according to A-TM 1.1.

3) Step the centre frequency of the measurement filter in contiguous steps and measure the emission within the specified frequency ranges with the specified measurement bandwidth.

4) Repeat the test for the remaining test cases, with the channel set-up according to A-TM 1.1.

6.5.4.5 Test requirements

6.5.5 Transmitter spurious emissions

6.6.5.1 Definition and applicability

The transmitter spurious emission limits shall apply from 9 kHz to 12.75 GHz, excluding the frequency range from Δf_{OBUE} below the lowest frequency of each supported downlink *operating band*, up to Δf_{OBUE} above the highest frequency of each supported downlink *operating band*, where the Δf_{OBUE} is defined in table 6.6.1. 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].

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

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

6.6.5.2 Minimum requirement

The minimum requirement applies per *single-band connector* supporting transmission in the *operating band*.

The minimum requirement for *BS type 1-C* is defined in TS 38.104 [2], clause 6.6.5.3.

6.6.5.3 Test purpose

This test measures conducted spurious emissions while the transmitter is in operation.

6.6.5.4 Method of test

6.6.5.4.1 Initial conditions

Test environment: Normal; see annex B.2.

RF channels to be tested for single carrier:

- B when testing the spurious emissions below $F_{DL\_low} - \Delta f_{OBUE,}$
- T when testing the spurious emissions above $F_{DL\_high} + \Delta f_{OBUE}$; see clause 4.7.1.

6.6.5.4.2 Procedure

1) Connect the *single-band connector* under test to measurement equipment as shown in annex D.1.1 for *BS type 1-C*. All connectors not under test shall be terminated.

2) Measurements shall use a measurement bandwidth in accordance to the conditions in clause 6.6.5.5.

   The measurement device characteristics shall be:

   - Detection mode: True RMS.

   The emission power should be averaged over an appropriate time duration to ensure the measurement is within the measurement uncertainty in Table 4.1.2.2-1.

3) For a connectors declared to be capable of single carrier operation only (D.16), set the representative connectors under test to transmit according to the applicable test configuration in clause 4.8 at *rated carrier output power* ($P_{rated,c,AC}$, or $P_{rated,c,TABC}$, D.21). Channel set-up shall be according to A-TM1.1.

4) Measure the emission at the specified frequencies with specified measurement bandwidth.

6.6.5.5 Test requirements

6.6.5.5.1 Basic limits

6.6.5.5.1.1 Tx spurious emissions

The limits of either table 6.6.5.5.1.1-1 (Category A limits) or table 6.6.5.5.1.1-2 (Category B limits) shall apply. The application of either Category A or Category B limits shall be the same as for operating band unwanted emissions in clause 6.6.4, and as declared by the manufacturer (D.4).

Table 6.6.5.5.1.1-1: General BS transmitter spurious emission limits in FR1, Category A

Spurious frequency range	*Basic limit*	Measurement bandwidth	Notes
9 kHz – 150 kHz	-13 dBm	1 kHz	Note 1, Note 4
150 kHz – 30 MHz		10 kHz	Note 1, Note 4
30 MHz – 1 GHz		100 kHz	Note 1
1 GHz – 12.75 GHz		1 MHz	Note 1, Note 2
12.75 GHz – 5th harmonic of the upper frequency edge of the DL *operating band* in GHz		1 MHz	Note 1, Note 2, Note 3
12.75 GHz - 26 GHz	-13 dBm	1 MHz	Note 1, Note 2, Note 5
NOTE 1: Measurement bandwidths 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 DL *operating band* is greater than 2.55 GHz and less than or equal to 5.2 GHz. NOTE 4: This spurious frequency range applies only to *BS type 1-C*. NOTE 5: Applies for Band for which the upper frequency edge of the DL *operating band* is greater than 5.2 GHz.			

Table 6.6.5.5.1.1-2: General BS transmitter spurious emission limits in FR1, Category B

Spurious frequency range	*Basic limit*	Measurement bandwidth	Notes
9 kHz – 150 kHz	-36 dBm	1 kHz	Note 1, Note 4
150 kHz – 30 MHz		10 kHz	Note 1, Note 4
30 MHz – 1 GHz		100 kHz	Note 1
1 GHz – 12.75 GHz	-30 dBm	1 MHz	Note 1, Note 2
12.75 GHz – 5th harmonic of the upper frequency edge of the DL *operating band* in GHz		1 MHz	Note 1, Note 2, Note 3
12.75 GHz - 26 GHz	-30 dBm	1 MHz	Note 1, Note 2, Note 5
NOTE 1: Measurement bandwidths 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 DL *operating band* is greater than 2.55 GHz and less than or equal to 5.2 GHz. NOTE 4: This spurious frequency range applies only to *BS type 1-C*. NOTE 5: Applies for Band for which the upper frequency edge of the DL *operating band* is greater than 5.2 GHz.			

6.6.5.5.1.2 Protection of the BS receiver of own or different BS

This requirement shall be applied for NR FDD operation in order to prevent the receivers of the BSs being desensitised by emissions from a BS transmitter. It is measured at the transmit *antenna connector* for *BS type 1-C* or at the *TAB connector* for *BS type 1-H* for any type of BS which has common or separate Tx/Rx *antenna connectors* / *TAB connectors*.

The *basic limits* are provided in table 6.6.5.5.1.2-1.

Table 6.6.5.5.1.2-1: BS spurious emissions *basic limits* for protection of the BS receiver

BS class	Frequency range	Basic limit	Measurement bandwidth
Wide Area BS	F_{UL_low} – F_{UL_high}	-96 dBm	100 kHz
Medium Range BS		-91 dBm	
Local Area BS		-88 dBm	
NOTE 1: For BS operating in band n104, the basic limit is increased by 1dB.			
NOTE 2: For BS operating in regions where a band is only partially allocated for NR operations (e.g. band n28), this requirement only applies in the UL frequency range of the partial allocation.			
NOTE 3: For BS capable of multi-band operation, Table 6.6.5.5.1.2-1 assumes that the supported *operating bands*, where the corresponding BS transmit and receive frequency ranges in table 5.2-1 in TS 38.104 [2] 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 protection requirements may apply that are not covered by the 3GPP specifications.			

6.6.5.5.1.3 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 4.4.

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 6.6.5.5.1.3-1 for a BS where requirements for co-existence with the system listed in the first column apply.

Table 6.6.5.5.1.3-1: BS spurious emissions *basic limits* for BS for co-existence with systems operating in other frequency bands

System type to co-exist with (Note 7)	Frequency range for co-existence requirement (MHz) (Note 8)	*Basic limits* (dBm)	Measurement bandwidth	Notes
GSM850 or CDMA850	869 - 894	-57	100 kHz	Note 1
	824 - 849	-61		
GSM900	921 - 960	-57		
	876 - 915	-61		
DCS1800	1805 - 1880	-47		
	1710 - 1785	-61		
PCS1900	1930 - 1990	-47		
	1850 - 1910	-61		
UTRA, E-UTRA or NR	Frequency range of downlink *operating band* of the BS to co-exist with	-52	1 MHz	Note 1, Note 9
	Frequency range of uplink *operating band* of the BS to co-exist with	-49		Note 1, Note 4, Note 5, Note 6

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 6.6.5.5.1.3-1 do not apply for the Δf_{OBUE} 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 6.6.5.5.1.3-1 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.

NOTE 3: TDD base stations deployed in the same geographical area, that are synchronized and use the same or adjacent *operating bands* can transmit without additional co-existence requirements. For unsynchronized base stations, special co-existence requirements may apply that are not covered by the 3GPP specifications.

NOTE 4: For NR Band n28 BS, specific solutions may be required to fulfil the spurious emissions limits for BS for co-existence with E-UTRA Band 27 UL *operating band*, where requirement applies 4 MHz above the Band n28 downlink operating band.

NOTE 5: For NR Band n29 BS, specific solutions may be required to fulfil the spurious emissions limits for NR BS for co-existence with UTRA Band XII, E-UTRA Band 12 or NR Band n12 UL operating band, E-UTRA Band 17 UL operating band or E-UTRA Band 85 UL or NR Band n85 UL operating band, where requirement applies 1 MHz below the Band n29 downlink operating band.

NOTE 6: For NR Band n67 BS, specific solutions may be required to fulfil the spurious emissions limits for NR BS co-existence with E-UTRA Band 28 or NR Band n28 UL operating band or NR Band n83 UL operating band, where requirement applies for 703 MHz to 736 MHz.

NOTE 7: Does not apply for co-existence with standalone downlink bands (SDO) defined in TS 36.104 [13], table 5.5-1.

NOTE 8: Frequency range of NR, UTRA and E-UTRA bands, as described in clause 5.2, TS 25.104 [29] clause 5.2 and TS 36.104 [13] clause 5.5, respectively.

NOTE 9: For TDD bands, -52 dBm/MHz basic limit applies.

6.6.5.5.1.4 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 6.6.5.5.1.4-1 for a BS where requirements for co-location with a BS type listed in the first column apply, depending on the declared BS class (D.2). For a *multi-band connector*, the exclusions and conditions in the Note column of table 6.6.5.5.1.4-1 shall apply for each supported *operating band*.

Table 6.6.5.5.1.4-1: BS spurious emissions *basic* limits for BS co-located with another BS

Frequency range of uplink operating band of the co-located BS (MHz) (Note 4)	System type to co-locate with	*Basic limits* (dBm/100kHz) (Note 1)		
		WA BS	MR BS	LA BS
824 - 849	GSM850 or CDMA850	-98	-91	-70
876 - 915	GSM900	-98	-91	-70
1710 - 1785	DCS1800	-98	-91	-80
1850 - 1910	PCS1900	-98	-91	-80
49, 51/n51, n91, n93	E-UTRA or NR	N/A	N/A	-88
46/n46, 53/n53	E-UTRA or NR	N/A	-91	-88
n100, n101	NR	-96	N/A	N/A
n96, n102	NR	N/A	-90	-87
n104	NR	-95	-90	-87
Other operating band	UTRA, E-UTRA or NR	-96	-91	-88

NOTE 1: As defined in the scope for spurious emissions in this clause, the co-location requirements in table 6.6.5.5.1.4-1 do not apply for the frequency range extending Δf_{OBUE} 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 6.6.5.5.1.4-1 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.

NOTE 3: Co-located TDD base stations that are synchronized and using the same or adjacent *operating band* can transmit without special co-locations requirements. For unsynchronized base stations, special co-location requirements may apply that are not covered by the 3GPP specifications.

NOTE 4: Frequency range of NR, UTRA and E-UTRA bands, as described in clause 5.2, TS 25.104 [29] clause 5.2 and TS 36.104 [13] clause 5.5, respectively.

6.6.5.5.2 *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 6.6.5.5.1.

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.
- Requirements shall be met for any transmitter setting.
- Throughput requirements defined for the conducted receiver characteristics do not assume HARQ retransmissions.
- For ACS, blocking and intermodulation characteristics, the negative offsets of the interfering signal apply relative to the lower *Base Station RF Bandwidth* edge, and the positive offsets of the interfering signal apply relative to the upper *Base Station RF Bandwidth* edge.

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

7.2 Reference sensitivity level

7.2.1 Definition and applicability

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 requirement for *BS type 1-C*

The minimum requirement for *BS type 1-C* is in TS 38.194 [3], clause 7.2.2.

7.2.3 Test purpose

To verify that for the *BS type 1-C* receiver *connector* at the reference sensitivity level the throughput requirement shall be met for a specified reference measurement channel.

7.2.4 Method of test

7.2.4.1 Initial conditions

Test environment:

- Normal; see annex B.2.
- Extreme, see annexes B.3 and B.5.

RF channels to be tested for single carrier: B, M and T; see clause 4.7.1.

Under extreme test environment, the test shall be performed on each of B, M and T under extreme power supply conditions as defined in annex B.5.

NOTE: Tests under extreme power supply conditions also test extreme temperatures.

7.2.4.2 Procedure

The minimum requirement is applied to all connectors under test.

For *BS type 1-C*, the procedure is repeated until all antenna *connectors* necessary to demonstrate conformance have been tested; see clause 7.1.

1) Connect the connector under test to measurement equipment as shown in annex D.2.1 for *BS type 1-C*.
2) For HD-FDD operation, set the BS to transmit a signal using the applicable test configuration and corresponding power setting specified in clauses 4.7 and 4.8 using the corresponding test models or set of physical channels in clause 4.9.2, for *BS type 1-C* set the *antenna connector* to the manufacturers declared *rated carrier output power* ($P_{rated,c,AC}$, D.21).
3) Start the signal generator for the wanted signal to transmit the Fixed Reference Channels for reference sensitivity according to annex A.1.
4) Set the signal generator for the wanted signal power as specified in clause 7.2.5.
5) Measure the BLER according to annex A.1.

7.2.5 Test requirements

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 7.2.5-1 for A-IoT Medium range BS.

Table 7.2.5-1: 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	-94.5
		A-FR1-A1-2	-91.5
3520	2880	A-FR1-A1-3	-71.7
		A-FR1-A1-4	-68.7
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 (ACS)

7.3.1.1 Definition and applicability

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

The minimum requirement for BS type 1-C are in TS 38.194 [3], clause 7.3.1.2.

7.3.1.3 Test purpose

The test purpose is to verify the ability of the BS receiver filter to suppress interfering signals in the channels adjacent to the wanted channel.

7.3.1.4 Method of test

7.3.1.4.1 Initial conditions

Test environment: Normal; see annex B.2.

RF channels to be tested for single carrier (SC): M; see clause 4.7.1.

7.3.1.4.2 Procedure

The minimum requirement is applied to all connectors under test.

For *BS type 1-C*, the procedure is repeated until all antenna *connectors* necessary to demonstrate conformance have been tested; see clause 7.1.

1) Connect the connector under test to measurement equipment as shown in annex D.2.3 for *BS type 1-C*.
2) For HD-FDD operation, set the BS to transmit:
   - For single carrier operation set the connector under test to transmit at manufacturers declared *rated carrier output power* ($P_{rated,c,AC}$, D.21).
3) Set the signal generator for the wanted signal to transmit as specified in table 7.3.1.5-1.
4) Set the signal generator for the interfering signal to transmit at the frequency offset and as specified in table 7.3.1.5-2.
5) Measure the BLER according to annex A.1.

7.3.1.5 Test requirements

The BLER performance shall be less than or equal to 10% of the reference measurement channel.

The wanted and the interfering signal coupled to the *BS type 1-C antenna connector* are specified in table 7.3.1.5-1 a. The reference measurement channel for the wanted signal is identified in table 7.3.1.5-1 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 E.

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 7.3.1.5-1: 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	±340	5 MHz DFT-s-OFDM NR signal, 15 kHz SCS, 1 RB, closest to wanted signal
3520	$P_{REFSENS}$ + 6dB (Note)	-53	±2500	5 MHz DFT-s-OFDM NR signal
NOTE: $P_{REFSENS}$ depends on the sub-carrier spacing as specified in Table 7.2.5-1				

7.3.2 In-band blocking

7.3.2.1 Definition and applicability

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

The minimum requirements for *BS type 1-C* are in TS 38.194 [3], clause 7.3.2.2.

7.3.2.3 Test purpose

The test purpose is to verify the ability of the BS receiver to withstand high-levels of in-band interference from unwanted signals at specified frequency offsets without undue degradation of its sensitivity.

7.3.2.4 Method of test

7.3.2.4.1 Initial conditions

Test environment: Normal; see annex B.2.

RF channels to be tested for single carrier (SC): M; see clause 4.7.1

7.3.2.4.2 Procedure for general blocking

The minimum requirement is applied to all connectors under test.

For *BS type 1-C*, the procedure is repeated until all antenna *connectors* necessary to demonstrate conformance have been tested; see clause 7.1.

1) Connect the connector under test to measurement equipment as shown in annex D.2.3 for *BS type 1-C*.

2) For HD-FDD operation, set the BS to transmit:

   - For single carrier operation set the connector under test to transmit at manufacturers declared *rated carrier output power* ($P_{rated,c,AC}$, D.21).

3) Set the signal generator for the wanted signal to transmit as specified in table 7.3.2.5-1.

4) Set the signal generator for the interfering signal to transmit at the frequency offset and as specified in table 7.3.2.5-1. The interfering signal shall be swept with a step size of 1 MHz starting from the minimum offset to the channel edges of the wanted signals as specified in table 7.3.2.5-1.

5) Measure the BLER according to annex A.1.

7.3.2.5 Test requirements

The BLER performance shall be less than or equal to 10% 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 7.3.2.5-1 for general blocking. The reference measurement channel for the wanted signal is identified in clause 7.2.5 for each *BS channel bandwidth* and further specified in annex A.1. The characteristics of the interfering signal is further specified in annex E.

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 7.3.2.5-0.

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

Table 7.3.2.5-0: 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

Table 7.3.2.5-1: 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* (MHz)	Type of interfering signal
200	$P_{REFSENS}$ + x dB	-38	±7.5	5 MHz DFT-s-OFDM NR signal 15 kHz SCS, 25 RBs
3520	$P_{REFSENS}$ + x dB	-38	±7.5	5 MHz DFT-s-OFDM NR signal 15 kHz SCS, 25 RBs
NOTE 1: $P_{REFSENS}$ depends also on the *BS channel bandwidth* as specified in tables 7.2.5-1 NOTE 2: For a BS capable of single band operation only, "x" is equal to 6 dB.				

7.4 Out-of-band blocking

7.4.1 Definition and applicability

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

The minimum requirements for *BS type 1-C* are in TS 38.194 [3], clause 7.4.2.

7.4.3 Test purpose

To verify that the *BS type 1-C* receiver dynamic range, the BLER performance shall fulfil the specified limit.

7.4.4 Method of test

7.4.4.1 Initial conditions

Test environment: Normal; see annex B.2.

RF channels to be tested for single carrier (SC):

- M; see clause 4.7.1

7.4.4.2 Procedure

The minimum requirement is applied to all connectors under test.

1) Connect the connector under test to measurement equipment as shown in annex [D.2.5] for *BS type 1-C*.
2) Set the signal generator for the wanted signal as defined in clause 7.4.5 to transmit as specified in table 7.4.5.1-1.
4) Set the Signal generator for the interfering signal to transmit at the frequency offset and as specified in table 7.4.5.1-1. The CW interfering signal shall be swept with a step size of 1 MHz over than range 1 MHz to (F_{UL_low} - Δf_{OOB}) MHz and (F_{UL_high} + Δf_{OOB}) MHz to 12750 MHz.
5) Measure the BLER performance according to annex A.1.

7.4.5 Test requirements

7.4.5.1 General requirements

The BLER performance shall be 10% of the reference measurement channel as specified in annex A.1, with a wanted and an interfering signal coupled to *BS type 1-C antenna connector* using the parameters in table 7.4.5.1-1.

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 E.

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* is defined in table 7.3.2.2-0.

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

Table 7.4.5.1-1: 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 Definition and applicability

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

7.5.2 Minimum requirement

The minimum requirements for *BS type 1-C* are in TS 38.194 [3], clause 7.5.2.

7.5.3 Test purpose

The test purpose is to verify the ability of the BS to limit the interference caused by receiver spurious emissions to other systems.

7.5.4 Method of test

7.5.4.1 Initial conditions

Test environment: Normal; see annex B.2.

RF channels to be tested for single carrier: M; see clause 4.7.1.

7.5.4.2 Procedure

The minimum requirement is applied to all connectors under test,

1) Connect the connector under test to measurement equipment as shown in annex D.2.6 for *BS type 1-C*.

2) Set the measurement equipment parameters as specified in Table 7.5.5.1-1.

   The measurement device characteristics shall be:

   - Detection mode: True RMS.

   The emission power should be averaged over an appropriate time duration to ensure the measurement is within the measurement uncertainty in Table 4.1.2.3-1.

4) Measure the spurious emissions over each frequency range described in Table 7.5.5.1-1.

7.5.5 Test requirements

7.5.5.1 Basic limits

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 7.5.5.1-1.

Table 7.5.5.1-1: 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
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: 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.			

7.6 Receiver intermodulation

7.6.1 Definition and applicability

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

The minimum requirements for *BS type 1-C* are in TS 38.194 [3], clause 7.6.2.

7.6.3 Test purpose

The test purpose is to verify the ability of the BS receiver to inhibit the generation of intermodulation products in its non-linear elements caused by the presence of two high-level interfering signals at frequencies with a specific relationship to the frequency of the wanted signal.

7.6.4 Method of test

7.6.4.1 Initial conditions

Test environment: Normal; see annex B.2.

RF channels to be tested for single carrier (SC): M; see clause 4.7.1

7.6.4.2 Procedure

The minimum requirement is applied to all connectors under test.

1) Connect the connector under test to measurement equipment as shown in annex D.2.7 for *BS type 1-C*.
2) Set the signal generator for the wanted signal to transmit as specified in table 7.7.5-1.
3) Set the signal generator for the interfering signal to transmit at the frequency offset and as specified in table 7.7.5-1.
4) Measure the BLER performance according to annex A.1.

7.6.5 Test requirements

The BLER performance shall be 10% of the reference measurement channel as specified in annex A.1, 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 7.7.5-1 for narrowband intermodulation performance. The reference measurement

channel for the wanted signal is identified in tables 7.2.2-1 for each *BS channel bandwidth* and further specified in annex A.1. The characteristics of the interfering signal is further specified in annex E.

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.

Table 7.6.5-1: 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 edg [kHz]	Type of interfering signal
200	$P_{REFSENS}$ + 6dB (Note 1)	-53	±340	CW
		-53	±780	5 MHz NR signal, 1 RB (Note 2)
3520	$P_{REFSENS}$ + 6dB (Note 1)	-53	±270	CW
		-53	±2300	5 MHz NR signal, 1 RB (Note 2)
NOTE 1: $P_{REFSENS}$ depends on the sub-carrier spacing as specified in Table 7.2.2-1. NOTE 2: 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

8.1.1 CW node

General test conditions for conducted transmitter tests of CW node are given in clause 8, including interpretation of measurement results and configurations for testing.

8.2 CW Output power

8.2.1 Definition and applicability

The conducted CW node output power requirements are specified at the antenna connector.

The rated output power of the CW node shall be less than or equal to +33 dBm.

8.2.2 Minimum requirement

The minimum requirement applies at the connector supporting transmission in the operating band (s).

The minimum requirement for CW node is defined in TS 38.194 [3], clause 8.2.2.

8.2.3 Test purpose

The test purpose is to verify the accuracy of the maximum output power across the frequency range and under normal and extreme conditions.

8.2.4 Method of test

8.2.4.1 Initial conditions

Test environment:

- Normal, see annex [B.2],
- Extreme, see annexes [B.3 and B.5].

RF frequency point to be tested for single-tone signal: B, M and T; see clause [4.7].

Under extreme test environment, it is sufficient to test on one RF frequency point position, and with the test configuration defined in clauses [4.5]. Testing shall be performed under extreme power supply conditions, as defined in [Annex B.5].

NOTE: Tests under extreme power supply conditions also test extreme temperatures.

8.2.4.2 Procedure

1) Connect the power measuring equipment to the connector under test as shown in [annex D.1.1] for CW node.
2) For single carrier, set the connector under test to transmit according to the applicable test configuration in clause [4.5] using the corresponding test models or set of test signal in clause [4.7] at rated output power P_{rated} for CW node.
3) Measure the maximum output power (P_{max}) at the connector under test.

8.2.5 Test requirement

For the connector under test, the power measured in clause 8.2.4.2 in step 3 shall remain within the values provided in table 8.2.5-1 for normal and extreme test environments, relative to the manufacturer's declared P_{rated} for CW node:

Table 8.2.5-1: Test requirement for conducted CW node output power

	Normal test environment	Extreme test environment
CW node	f ≤ 3.0 GHz: ± 2.7 dB	f ≤ 3.0 GHz: ± 3.2 dB
NOTE: Apply for CW node operates in licensed spectrum only.		

8.3 Frequency error

8.3.1 Definition and applicability

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

For CW node, this requirement shall be applied at the antenna connector supporting transmission in the operating band.

8.3.2 Minimum Requirement

The minimum requirement is in TS 38.194 [3], clause 8.3.2.

8.3.3 Test purpose

The test purpose is to verify that frequency error is within the limit specified by the minimum requirement.

8.3.4 Method of test

8.3.4.1 Initial conditions

Test environment: Normal; see [annex B.2].

RF frequency point to be tested for single signal: M; see clause [4.7].

8.3.4.2 Procedure

1) Connect the connector under test to measurement equipment as shown in [annex D.1.1] for CW node.

2) For a connector declared to be capable of single-tone operation only ([D.16]), set the representative connector under test to transmit according to the applicable test configuration in clause [4.5] at rated output power (P_{rated}, [D.21]).

3) Measure the frequency error at the connector under test.

8.3.5 Test Requirements

Table 8.3.5-1: Frequency error test requirement

DUT	Accuracy
CW node	±(0.1 ppm + 12 Hz)

8.4 Unwanted emission

8.4.1 Phase noise

8.4.1.1 Definition and applicability

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

- Δf is the frequency offset from the phase noise frequency point to the centre frequency of carrier wave.

For the CW equipment declared capable of performing phase noise cancellation, the requirement in clause 8.4.1.5 is not applied.

8.4.1.2 Minimum requirement

The minimum requirement applies the connector supporting transmission in the operating band.

The minimum requirement for CW node is defined in TS 38.194 [3], clause 8.5.2.2.

8.4.1.3 Test purpose

The test purpose is to verify that phase noise is within the limit specified by the minimum requirement.

8.4.1.4 Method of test

8.4.1.4.1 Initial conditions

Test environment: Normal; see [annex B.2].

RF frequency point to be tested for single-tone signal: M; see clause [4.7].

8.4.1.4.2 Procedure

1) Connect the connector under test to measurement equipment as shown in [annex D.1.1] for CW node.

2) For a connector declared to be capable of single-tone operation only ([D.16]), set the representative connector under test to transmit according to the applicable test configuration in clause [4.5] at rated output power (P_{rated}, [D.21]).

3) Measure the phase noise at the connector under test.

8.4.1.5 Test requirements

The phase noise power of CW transmitter shall not exceed the levels specified in Table 8.4.1.5-1.

Table 8.4.1.5-1: CW phase noise emission limit

Δf (kHz)	Phase noise emission limit (dBc/Hz)
± 7.5	-97 ± [x]
± 120	-102 ± [x]

8.4.2 Operating band unwanted emissions

8.4.2.1 Definition and applicability

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. Basic limits are 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.

8.4.2.2 Minimum requirement

The minimum requirement applies the connector supporting transmission in the operating band.

The minimum requirement for CW node is defined in TS 38.194 [3], clause 8.5.3.2.

8.4.2.3 Test purpose

This test measures the emissions close to the assigned transmission frequency of the wanted signal, while the transmitter is in operation.

8.4.2.4 Method of test

8.4.2.4.1 Initial conditions

Test environment: Normal; see [annex B.2].

RF frequency point to be tested for single-tone signal: B, M and T; see clause [4.7].

8.4.2.4.2 Procedure

1) Connect the connector under test to measurement equipment as shown in [annex D.1.1] for CW node.

   As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity, efficiency and avoiding e.g. carrier leakage, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

The measurement device characteristics shall be:

- Detection mode: True RMS.

The emission power should be averaged over an appropriate time duration to ensure the measurement is within the measurement uncertainty in [Table 4.1.2.2-1].

2) For a connector declared to be capable of single-tone operation only, set the representative connector under test to transmit according to the applicable test configuration in clause [4.5] at output power P_{rated} for CW node. Test signal set-up shall be according to Annex D.1.1.

3) Step the centre frequency of the measurement filter in contiguous steps and measure the emission within the specified frequency ranges with the specified measurement bandwidth.

4) Repeat the test for the remaining test cases, with the test signal set-up according to Annex D.1.1.

8.4.2.5 Test requirements

8.4.2.5.1 General requirements

For CW node operating in Band n8, basic limits are specified in tables 8.4.2.5.1-1. The spectrum emission limit between each Δf is linearly interpolated.

Table 8.4.2.5.1-1: CW node Operating band unwanted emissions

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

8.4.3 Transmitter spurious emissions

8.4.3.1 Definition and applicability

The transmitter spurious emission limits shall apply from 9 kHz to 12.75 GHz, excluding the frequency range 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..

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

8.4.3.2 Minimum requirement

The minimum requirement applies connector supporting transmission in the operating band.

The minimum requirement for CW node is defined in TS 38.194 [3], clause 8.5.4.2.

8.4.3.3 Test purpose

This test measures conducted spurious emissions while the transmitter is in operation.

8.4.3.4 Method of test

8.4.3.4.1 Initial conditions

Test environment: Normal; see [annex B.2].

RF frequency point to be tested for single-tone signal:

- B when testing the spurious emissions below F_{UL_low} - 10 MHz,
- T when testing the spurious emissions above F_{UL_high} + 10 MHz; see clause [4.7].

8.4.3.4.2 Procedure

1) Connect the connector under test to measurement equipment as shown in [annex D.1.1] for CW node.
2) Measurements shall use a measurement bandwidth in accordance to the conditions in clause 8.4.3.5.

   The measurement device characteristics shall be:

   - Detection mode: True RMS.

   The emission power should be averaged over an appropriate time duration to ensure the measurement is within the measurement uncertainty in Table [4.1.2.2-1].
3) For a connector declared to be capable of single-tone operation only ([D.16]), set the representative connector under test to transmit according to the applicable test configuration in clause [4.5] at rated output power (P_{rated}, D.21). Test signal set-up shall be according to Annex D.1.1.
4) Measure the emission at the specified frequencies with specified measurement bandwidth.

8.4.3.5 Test requirements

8.4.3.5.1 Basic limits

8.4.3.5.1.1 Tx spurious emissions

The limits of table 8.4.3.5.1.1-1 (Category B limits) shall apply. The application of Category B limits shall be the same as for operating band unwanted emissions in clause 8.4.2, and as declared by the manufacturer ([D.4]).

Table 8.4.3.5.1.1-1: 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

9 Conducted performance characteristics

Annex A (normative): Reference measurement channels

Annex B (normative): Environmental requirements for the BS or CW node equipment

B.1 General

For each test in the present document, the environmental conditions under which the BS is to be tested are defined.

B.2 Normal test environment

When a normal test environment is specified for a test, the test should be performed within the minimum and maximum limits of the conditions stated in table B.1.

Table B.1: Limits of conditions for normal test environment

Condition	Minimum	Maximum
Barometric pressure	86 kPa	106 kPa
Temperature	15 °C	30 °C
Relative humidity	20 %	85 %
Power supply	Nominal, as declared by the manufacturer	
Vibration	Negligible	

The ranges of barometric pressure, temperature and humidity represent the maximum variation expected in the uncontrolled environment of a test laboratory. If it is not possible to maintain these parameters within the specified limits, the actual values shall be recorded in the test report.

NOTE: This may, for instance, be the case for measurements of radiated emissions performed on an open field test site.

B.3 Extreme test environment

B.3.0 General

The manufacturer shall declare one of the following:

1) The equipment class for the equipment under test, as defined in the IEC 60 721-3-3 [6];

2) The equipment class for the equipment under test, as defined in the IEC 60 721-3-4 [7];

3) The equipment that does not comply with the mentioned classes, the relevant classes from IEC 60 721 [8] documentation for temperature, humidity and vibration shall be declared.

NOTE: Reduced functionality for conditions that fall outside of the standard operational conditions is not tested in the present document. These may be stated and tested separately.

B.3.1 Extreme temperature

When an extreme temperature test environment is specified for a test, the test shall be performed at the standard minimum and maximum operating temperatures defined by the manufacturer's declaration for the equipment under test.

Minimum temperature:

The test shall be performed with the environment test equipment and methods including the required environmental phenomena into the equipment, conforming to the test procedure of IEC 60 068-2-1 [9].

Maximum temperature:

The test shall be performed with the environmental test equipment and methods including the required environmental phenomena into the equipment, conforming to the test procedure of IEC 60 068-2-2 [10].

NOTE: It is recommended that the equipment is made fully operational prior to the equipment being taken to its lower operating temperature.

B.4 Vibration

When vibration conditions are specified for a test, the test shall be performed while the equipment is subjected to a vibration sequence as defined by the manufacturer's declaration for the equipment under test. This shall use the environmental test equipment and methods of inducing the required environmental phenomena in to the equipment, conforming to the test procedure of IEC 60 068-2-6 [11]. Other environmental conditions shall be within the ranges specified in annex B.2.

NOTE: The higher levels of vibration may induce undue physical stress in to equipment after a prolonged series of tests. The testing body should only vibrate the equipment during the RF measurement process.

B.5 Power supply

When extreme power supply conditions are specified for a test, the test shall be performed at the standard upper and lower limits of operating voltage defined by manufacturer's declaration for the equipment under test.

Upper voltage limit:

The equipment shall be supplied with a voltage equal to the upper limit declared by the manufacturer (as measured at the input terminals to the equipment). The tests shall be carried out at the steady state minimum and maximum temperature limits declared by the manufacturer for the equipment, to the methods described in IEC 60 068-2-1 [9] Test Ab/Ad and IEC 60 068-2-2 [10] Test Bb/Bd: Dry heat.

Lower voltage limit:

The equipment shall be supplied with a voltage equal to the lower limit declared by the manufacturer (as measured at the input terminals to the equipment). The tests shall be carried out at the steady state minimum and maximum temperature limits declared by the manufacturer for the equipment, to the methods described in IEC 60 068-2-1 [9] Test Ab/Ad and IEC 60 068-2-2 [10] Test Bb/Bd: Dry heat.

B.6 Measurement of test environments

The measurement accuracy of the BS test environments defined in annex B shall be:

Pressure: ±5 kPa

Temperature: ±2 degrees

Relative humidity: ±5 %

DC voltage: ±1.0 %

AC voltage: ±1.5 %

Vibration: 10 %

Vibration frequency: 0.1 Hz

The above values shall apply unless the test environment is otherwise controlled and the specification for the control of the test environment specifies the uncertainty for the parameter.

Annex C (informative):
Test tolerances and derivation of test requirements

Annex D (informative): Measurement system set-up

D.1 BS and CW node transmitter

D.1.1 Base station and CW node output power, transmitter ON/OFF power, frequency error, transmitted signal quality, unwanted emissions

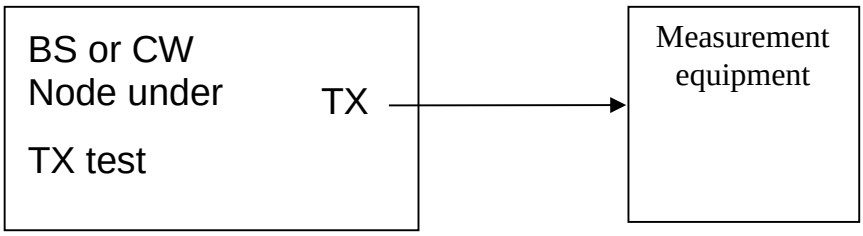

Figure D.1.1-1: Measuring system set-up for *BS and CW node* output power, transmitter ON/OFF power, frequency error, transmitted signal quality, unwanted emissions

Annex E (normative): Characteristics of 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 E-1: Modulation of the interfering signal

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

Annex F (informative): Change history

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2025-10	RAN4#116 bis	R4-2513774	-	-	-	TS skeleton	0.0.1
2025-11	RAN4#117	R4-2521702	-	-	-	Agreed Text Proposal in RAN4 #117: R4-2522951, "draft TP for TS 38195 General test conditions and operating band" R4-2522952, "draft TP for TS 38195 BS TX conformance testing" R4-2522953, "TP to TS 38.915: clause 7.1 to 7.3" R4-2522954, "TP to TS 38.195 for Receiver OOB, Spurious and intermodulation" R4-2522955, "draft TP for TS 38.195 to introduce A-IoT CW transmitter characteristics"	0.1.0
2026-02	RAN4#118	R4-2601904	-	-	-	Agreed Text Proposal in RAN4 #118 R4-2602895, "TP for TS 38.195 BS and CW req" R4-2602994, "draft TP for TS38195 BS TX" R4-2602897, "Maintenance TP to TS 38.915" R4-2602898, "TP to TS 38.195 for Tx modulation"	0.2.0
2026-03	RAN#111	RP-260419	-	-	-	Presented to TSG RAN for approval.	1.0.0

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2026-03	RAN#111					Approved by plenary – Rel-19 spec under change control	19.0.0

History

Version	Date	Status
V19.0.0	April 2026	Publication