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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;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

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

shall indicates a mandatory requirement to do something

shall not indicates an interdiction (prohibition) to do something

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

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

should indicates a recommendation to do something

should not indicates a recommendation not to do something

may indicates permission to do something

need not indicates permission not to do something

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

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

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 NR *Repeater type 2-O*. These have been derived from, and are consistent with the radiated requirements for *Repeater type 2-O* in Repeater specification defined in TS 38.106 [2].

A *repeater type 1-C* only has conducted requirements so it does not require compliance to this specification.

Repeater type 2-O have only radiated requirements so they require compliance to this specification only.

2 References

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

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

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications"

[2] 3GPP TS 38.106: "NR repeater radio transmission and reception"

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

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

[5] 3GPP TS 38.104: "NR Base Station (BS) radio transmission and reception"

[6] 3GPP TS 38.141-2: "NR; Base Station (BS) conformance testing; Part 2: Radiated conformance testing"

[7] IEC 60 721-3-3: "Classification of environmental conditions - Part 3-3: Classification of groups of environmental parameters and their severities - Stationary use at weather protected locations"

[8] IEC 60 721-3-4: "Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Clause 4: Stationary use at non-weather protected locations"

[9] IEC 60 721: "Classification of environmental conditions"

[10] IEC 60 068-2-1: "Environmental testing - Part 2: Tests. Tests A: Cold"

[11] IEC 60 068-2-2: "Environmental testing - Part 2: Tests. Tests B: Dry heat"

[12] IEC 60 068-2-6: "Environmental testing - Part 2: Tests - Test Fc: Vibration (sinusoidal)"

[13] 3GPP TR 37.941: "Radio Frequency (RF) conformance testing background for radiated Base Station (BS) requirements"

[14] 3GPP TS 38.101-2: "NR; User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone".

[15] Commission Implementing Decision (EU) 2020/590 of 24 April 2020 amending Decision (EU) 2019/784 as regards an update of relevant technical conditions applicable to the 24,25-27,5 GHz frequency band.

[16] 3GPP TS 38.211: "NR; Physical channels and modulation".

[17] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification".

3 Definitions of terms, symbols and abbreviations

3.1 Terms

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

Beam: beam (of the antenna) is the main lobe of the radiation pattern of an *antenna array*

Beam centre direction: direction equal to the geometric centre of the half-power contour of the beam

Beam direction pair: data set consisting of the *beam centre direction* and the related *beam peak direction*

Beam peak direction: direction where the maximum EIRP is found

Beamwidth: beam which has a half-power contour that is essentially elliptical, the half-power beamwidths in the two pattern cuts that respectively contain the major and minor axis of the ellipse

directional requirement: requirement which is applied in a specific direction within the *OTA coverage range*.**Equivalent isotropic radiated power:** equivalent power radiated from an isotropic directivity device producing the same field intensity at a point of observation as the field intensity radiated in the direction of the same point of observation by the discussed device

Fractional bandwidth: *fractional bandwidth* FBW is defined as $FBW = 200 \cdot \frac{F_{FBW\,high} - F_{FBW\,low}}{F_{FBW\,high} + F_{FBW\,low}}\%$

gap between passbands: frequency gap between two consecutive passbands that belong to the same *operating band*, where the RF requirements in the gap are based on co-existence for un-coordinated operation

Inter-passband gap: The frequency gap between two supported consecutive *passbands* that belong to different operating bands.

Maximum passband TRP output power: mean power level measured per passband during the *transmitter ON state* in a specified reference condition and corresponding to the declared *rated passband TRP output* power ($P_{rated,p,,TRP}$)

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

Nominal channel bandwidth: Bandwidth calculated as min(100MHz, $BW_{passband}$) in FR1 or min(400MHz, $BW_{passband}$) in FR2. If this bandwidth is not defined for BS channel bandwidth for the operating band, *nominal channel bandwidth* shall be defined as the widest BS channel bandwidth for the operating band which is narrower than $BW_{passband}$.

Non-contiguous spectrum: spectrum consisting of two or more *passbands* separated by *inter-passband gap*(s).

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

OTA coverage range: a common range of directions within which OTA requirements that are neither specified in the *OTA peak directions sets* nor as *TRP requirement* are intended to be met

OTA peak directions set: set(s) of *beam peak directions* within which certain OTA requirements are intended to be met, where all *OTA peak directions set(s)* are subsets of the *OTA coverage range***Passband:** The frequency range in which the repeater operates in with operational configuration, this frequency range can correspond to one or several consecutive nominal channels, if they are not consecutive each subset of channels shall be considered as an individual *passband*, a repeater can have one or several *passbands*, all channels within the *passband(s)* shall belong to a single operator or collaborating operators.

passband edge*:* Frequency at the edge of the passband

Repeater RF Bandwidth: RF bandwidth in which a repeater transmits and/or receives single or multiple passband(s) within a supported operating band

NOTE: In single passband operation, the Repeater RF Bandwidth is equal to the passband bandwidth.

Radiated interface boundary: *operating band* specific radiated requirements reference where the radiated requirements apply

Rated beam EIRP: For a declared beam and *beam direction pair*, the *rated beam EIRP* level is the maximum power that the repeater is declared to radiate at the associated *beam peak direction* during the *transmitter ON state*

Rated passband TRP output power: mean power level declared by the manufacturer per passband, that the manufacturer has declared to be available at the RIB during the *transmitter ON state*

Rated total TRP output power: mean power level associated with a particular *operating band*, that the manufacturer has declared to be available at the RIB during the *transmitter ON state* in a specified reference condition

Reference beam direction pair: Beam direction pair in the reference direction declared by the manufacturer.

Repeater type 2-O: Repeater operating at FR2 with a requirement set consisting only of OTA requirements defined at the RIB

Requirement set: one of the NR requirements set as defined for *NR repeater*

Sub-band: A *sub-band* of an operating band contains a part of the uplink and downlink frequency range of the operating band.

sub-block: one contiguous allocated block of spectrum for transmission and reception by the repeater.

Superseding-band: A *superseding-band* of an operating band includes the whole of the uplink and downlink frequency range of the operating band.

Total radiated power: is the total power radiated by the antenna

NOTE: The *total radiated power* is the power radiating in all direction for two orthogonal polarizations. *Total radiated power* is defined in both the near-field region and the far-field region

Transmitter OFF state: Time period during which the repeater downlink or uplink is not allowed to transmit in the corresponding direction.

Transmitter ON state: Time period during which the repeater is transmitting downlink or uplink signals in the corresponding direction.

Transmitter transient period: Time period during which the repeater is changing from the OFF state to the ON state or vice versa.

3.2 Symbols

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

BW_{Config}	Transmission bandwidth configuration, where $BW_{Config} = N_{RB}$ x SCS x 12
$BW_{Nominal}$	Nominal channel bandwidth
$BW_{Passband}$	*Passband* bandwidth
Δf	Separation between the *passband 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_{OBUE}	Maximum offset of the *operating band* unwanted emissions mask from the *operating band* edge$F_{DL,low}$ The lowest frequency of the downlink *operating band*
$F_{DL,high}$	The highest frequency of the downlink *operating band*
$F_{FBWhigh}$	Highest supported frequency within supportedoperating band, for which *fractional bandwidth* support was declared
F_{FBWlow}	Lowest supported frequency within supported operating band, for which *fractional bandwidth* support was declared
F_{filter}	Filter centre frequency

$F_{offset,high}$ Frequency offset from $F_{C,high}$ to the upper *passband edge*
$F_{offset,low}$ Frequency offset from $F_{C,low}$ to the lower *passband edge*
f_offset Separation between the *passband edge* frequency and the centre of the measuring
f_offset$_{max}$ The offset to the frequency Δf_{OBUE} outside the *operating band*
$F_{step,X}$ Frequency steps for the OTA transmitter spurious emissions (Category B)
$F_{UL,low}$ The lowest frequency of the uplink *operating band*
$F_{UL,high}$ The highest frequency of the uplink *operating band*
$P_{EM,n50/n75,ind}$ Declared emission level for Band n50/n75; ind = a, b
$P_{rated,in}$ Rated pass band input power to the repeater for the test
$P_{rated,p,EIRP}$ Rated passband EIRP output power
$P_{rated,p,TRP}$ Rated passband TRP output power declared per RIB
$P_{rated,t,TRP}$ Rated total TRP output power declared per RIB
$P_{in,p,EIRP}$ Input power intended to produce the maximum rated output power ($P_{rated,p,TRP}$) at the RIB$P_{rated,out,FBWhigh}$ The rated output EIRP for the higher supported frequency range within supported *operating band*, for which *fractional bandwidth* support was declared
$P_{rated,out,FBWlow}$ The rated output EIRP for the lower supported frequency range within supported *operating band*, for which *fractional bandwidth* support was declared$P_{max,p,EIRP}$ *Maximum passband EIRP output power* when repeater is configured at the rated passband TRP output power ($P_{rated,p,TRP}$)
$P_{max,p,TRP}$ *Maximum passband TRP output power* measured per RIB
W_{gap} *Inter passband Bandwidth gap* size

3.3 Abbreviations

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

ACLR Adjacent Channel Leakage Ratio
AoA Angle of Arrival
BW Bandwidth
CACLR Cumulative ACLR
CP-OFDM Cyclic Prefix-OFDM
DFT-s-OFDM Discrete Fourier Transform-spread-OFDM
DL Downlink
EIRP Effective Isotropic Radiated Power
EVM Error Vector Magnitude
FBW Fractional Bandwidth
FR Frequency Range
ITU-R Radiocommunication Sector of the International Telecommunication Union
LA Local Area
MR Medium Range
NR New Radio
OBUE Operating Band Unwanted Emissions
OOB Out-of-band
OTA Over-The-Air
QAM Quadrature Amplitude Modulation
RF Radio Frequency
RIB Radiated Interface Boundary
RX Receiver
SCS Sub-Carrier Spacing
TX Transmitter
TRP Total Radiated Power
UL Uplink
WA Wide Area

4 General radiated 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 part 2 of this specification, i.e., to all radiated tests defined for FR2. The FR2 frequency range is defined in clause 5.1 of TS 38.106 [2].

The minimum requirements are given in TS 38.106 [2]. Test Tolerances for the radiated 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.

4.1.2.2 Radiated characteristics measurements

The maximum OTA Test System uncertainty for radiated characteristics measurements are given in tables 4.1.2.2-1. Details for derivation of OTA Test System uncertainty are given in corresponding clauses in TR 37.941 [13].

Table 4.1.2.2-1: Maximum Test System uncertainty for radiated characteristics tests

Clause	Maximum Test System Uncertainty	Derivation of Test System Uncertainty
6.2 Radiated transmit power (EIRP)	Normal condition: ±1.7 dB (24.25 – 29.5 GHz) ±2.0 dB (37 – 43.5 GHz) ±2.2 dB (43.5 GHz < f ≤ 48.2 GHz)	
	Extreme condition: ±3.1 dB (24.25 – 29.5 GHz) ±3.3 dB (37 – 43.5 GHz) ±3.5 dB (43.5 GHz < f ≤ 48.2 GHz)	
6.3 OTA repeater output power (TRP)	±2.1 dB (24.25 – 29.5 GHz) ±2.4 dB (37 – 43.5 GHz) ±2.6 dB (43.5 GHz < f ≤ 48.2 GHz)	
6.4 OTA frequency stability	±12 Hz Measurement results of ± 5000 Hz	
6.5 OTA out of band gain	±2.1 dB, 24.25GHz < f □ 29.5GHz ±2.4 dB, 37GHz < f □ 43,5GHz ±2.6 dB, 43.5GHz < f □ 48.2GHz	
6.6.2 OTA ACLR	Relative ACLR: ±2.3 dB (24.25 – 29.5 GHz) ±2.6 dB (37 – 43.5 GHz) ±2.8 dB (43.5 GHz < f ≤ 48.2 GHz) Absolute ACLR: ±2.7 dB (24.25 – 29.5 GHz) ±2.7 dB (37 – 43.5 GHz) ±2.9 dB (43.5 GHz < f ≤ 48.2 GHz)	
6.6.3 OTA operating band unwanted emission	±2.7 dB (24.25 – 29.5 GHz) ±2.7 dB (37 – 43.5 GHz) ±2.9 dB (43.5 GHz < f ≤ 48.2 GHz)	
6.6.4 OTA spurious emissions	±2.3 dB, 30 MHz ≤ f ≤ 6 GHz ±2.7 dB, 6 GHz < f ≤ 40 GHz ±5.0 dB, 40 GHz < f ≤ 60 GHz	
6.7 OTA EVM	1.25% signal analyser 2% stimulus signal	
6.8 OTA input intermodulation	 ±3.9 dB, 24.25 GHz < f ≤ 29.5 GHz ±3.9 dB, 37 GHz < f ≤ 43.5 GHz ±5.4 dB, 43.5 GHz < f ≤ 48.2 GHz	
6.9 OTA ACRR	±2.7 dB (24.25 – 29.5 GHz) ±2.7 dB (37 – 43.5 GHz) ±2.9 dB (43.5 GHz < f ≤ 48.2 GHz)	
6.10.1 OTA transmitter OFF power	±2.9 dB (24.25 – 29.5 GHz) ±3.3 dB (37 – 43.5 GHz) ±3.6 dB (43.5 GHz < f ≤ 48.2 GHz)	
6.10.2 OTA transient period	N/A	

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 [3].

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.