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Contents

Foreword 10

1 Scope 12

2 References 12

3 Definitions of terms, symbols and abbreviations 13

3.1 Terms 13

3.2 Symbols 13

3.3 Abbreviations 14

4 General 15

4.1 Relationship between minimum requirements and test requirements 15

4.2 Applicability of minimum requirements 15

4.3 Specification Suffix Information 15

5 Operating bands and channel arrangement 16

5.1 General 16

5.2 Operating bands 16

5.2A Operating bands for UE category M1 16

5.2B Operating bands for category NB1 and NB2 16

5.3 Channel bandwidth 17

5.3A Channel bandwidth for category M1 17

5.3B Channel bandwidth for category NB1 and NB2 17

5.4 Channel arrangement 18

5.4A Channel arrangement for category M1 18

5.4A.1 Channel spacing 18

5.4A.2 Channel raster, carrier frequency and EARFCN 19

5.4A.3 TX–RX frequency separation 19

5.4B Channel arrangement for category NB1 and NB2 20

5.4B.1 Channel spacing 20

5.4B.2 Channel raster, carrier frequency and EARFCN 20

5.4B.3 TX–RX frequency separation 20

6 Transmitter characteristics 20

6.1 General 20

6.2 Transmit power 20

6.2A Transmit power for category M1 21

6.2A.1 UE maximum output power for category M1 21

6.2A.2 UE maximum output power reduction for category M1 21

6.2A.3 UE additional maximum output power reduction for category M1 UE 22

6.2A.4 Configured transmitted Power for category M1 22

6.2B Transmit power for category NB1 and NB2 22

6.2B.1 UE maximum output power for category NB1 and NB2 22

6.2B.2 UE maximum output power reduction for category NB1 and NB2 23

6.2B.3 UE additional maximum output power reduction for category NB1 and NB2 UE 23

6.2B.4 Configured transmitted Power for category NB1 and NB2 23

6.3 Output power dynamics 24

6.3A Output power dynamics for category M1 24

6.3A.1 UE Minimum output power for category M1 24

6.3A.2 Transmit OFF power for category M1 24

6.3A.3 ON/OFF time mask for category M1 24

6.3A.4 Power control for category M1 24

6.3B Output power dynamics for category NB1 and NB2 24

6.3B.1 UE Minimum output power for category NB1 and NB2 24

6.3B.2 Transmit OFF power for category NB1 and NB2 24

6.3B.3 ON/OFF time mask for category NB1 and NB2 25

6.3B.4 Power Control for category NB1 and NB2 25

6.4 Transmit signal quality 25

6.4A Transmit signal quality for category M1 25

6.4A.1 Frequency error for UE category M1 25

6.4A.2 Transmit modulation quality for category M1 26

6.4B Transmit signal quality for category NB1 and NB2 26

6.4B.1 Frequency error for UE category NB1 and NB2 26

6.4B.2 Transmit modulation quality for Category NB1 and NB2 26

6.5 Output RF spectrum emissions 27

6.5A Output RF spectrum emissions for category M1 27

6.5A.1 General 27

6.5A.2 Occupied bandwidth for category M1 27

6.5A.3 Out of band emission for category M1 27

6.5A.3.1 General 27

6.5A.3.2 Spectrum emission mask 27

6.5A.3.3 Additional Spectrum Emission Mask for category M1 28

6.5A.3.4 Adjacent Channel Leakage Ratio for category M1 28

6.5A.4 Spurious emission for category M1 28

6.5A.4.1 General 28

6.5A.4.2 Minimum requirements 28

6.5A.4.3 Spurious emission band UE co-existence 29

6.5A.4.4 Additional spurious emissions 30

6.5A.4.4.1 General 30

6.5A.4.4.2 Minimum requirement (network signalled value "NS\_02N") 30

6.5A.4.4.3 Minimum requirement (network signalled value "NS\_24") 31

6.5A.4.4.4 Minimum requirement (network signalled value "NS\_03N") 31

6.5A.4.4.5 Minimum requirement (network signalled value "NS\_04N") 31

6.5A.4.4.6 Minimum requirement (network signalled value "NS\_05N") 32

6.5B Output RF spectrum emissions for category NB1 and NB2 32

6.5B.1 General 32

6.5B.2 Occupied bandwidth for category NB1 and NB2 33

6.5B.3 Out of band emission for category NB1 and NB2 33

6.5B.3.1 General 33

6.5B.3.2 Spectrum emission mask 33

6.5B.3.3 Additional Spectrum Emission Mask for category NB1 and NB2 33

6.5B.3.4 Adjacent Channel Leakage Ratio for category NB1 and NB2 33

6.5B.4 Spurious emission for category NB1 and NB2 34

6.5B.4.1 General 34

6.5B.4.2 Minimum requirements 34

6.5B.4.3 Spurious emission band UE co-existence 34

6.5B.4.4 Additional spurious emissions 34

6.5B.4.4.1 General 34

6.5B.4.4.2 Minimum requirement (network signalled value "NS\_02N") 35

6.5B.4.4.3 Minimum requirement (network signalled value "NS\_24") 35

6.5B.4.4.4 Minimum requirement (network signalled value "NS\_03N") 35

6.5B.4.4.5 Minimum requirement (network signalled value "NS\_04N") 36

6.5B.4.4.6 Minimum requirement (network signalled value "NS\_05N") 36

6.6 Transmit intermodulation 36

6.6A Transmit intermodulation for category M1 36

6.6B Transmit intermodulation for category NB1 and NB2 36

7 Receiver characteristics 36

7.1 General 36

7.2 Diversity characteristics 36

7.3 Reference sensitivity power level 36

7.3A Reference sensitivity power level for UE category M1 37

7.3B Reference sensitivity power level for UE category NB1 and NB2 38

7.4 Maximum input level 38

7.4A Maximum input level for category M1 38

7.4B Maximum input level for category NB1 and NB2 38

7.5 Adjacent Channel Selectivity (ACS) 39

7.5A Adjacent Channel Selectivity for category M1 39

7.5B Adjacent Channel Selectivity for category NB1 and NB2 40

7.6 Blocking characteristics 40

7.6A Blocking characteristics for category M1 41

7.6A.1 General 41

7.6A.2 In-band blocking requirements for category M1 41

7.6A.3 Out-of-band blocking requirements for category M1 42

7.6A.4 Narrow band blocking for category M1 42

7.6B Blocking characteristics for category NB1 and NB2 43

7.6B.1 General 43

7.6B.2 In-band blocking requirements for category NB1 and NB2 43

7.6B.3 Out-of-band blocking requirements for category NB1 and NB2 43

7.6B.4 Narrow band blocking for category NB1 and NB2 44

7.7 Spurious response 44

7.7A Spurious response for category M1 44

7.7B Spurious response for category NB1 and NB2 45

7.8 Intermodulation characteristics 45

7.8A Intermodulation characteristics for category M1 45

7.8B Intermodulation characteristics for category NB1 and NB2 45

7.9 Spurious emissions 46

8 Performance requirement 46

8.1 General 46

8.1.1 Receiver antenna capability 46

8.1.2 Applicability of requirements 46

8.1.2.1 Applicability of requirements for different channel bandwidths 46

8.2.1.2 Applicability of requirements for optional UE features 46

8.1.3 UE category and UE DL category 47

8.2 Demodulation performance requirements for UE category M1 47

8.2.1 FDD and half-duplex FDD 47

8.2.1.1 PDSCH 47

8.2.1.1.1 Single-antenna port performance 48

8.3 Demodulation performance requirements for UE category NB1 and NB2 50

8.3.1 Half-duplex FDD 50

8.3.1.1 NPDSCH demodulation requirements 50

8.3.1.1.1 Single-antenna port performance 50

Annex A (normative): Measurement channels 52

A.1 DL reference measurement channels 52

A.1.1 Reference measurement channels for NPDSCH performance requirements 52

A.1.1.1 Standalone 52

A.1.2 Reference measurement channels for PDSCH performance requirements 53

A.1.2.1 Single-antenna transmission (Common Reference Symbols) 53

A.2 OFDMA Channel Noise Generator (OCNG) 53

A.2.1 OCNG Patterns for Narrowband IoT 53

A.2.1.1 Narrowband IoT OCNG pattern 1 54

A.2.2 OCNG Patterns for FDD 54

A.2.2.1 OCNG FDD Pattern 1: Two sided dynamic OCNG FDD pattern 55

A.3 Testing related to Satellite Access 55

A.3.1 General 55

A.3.2 Test condition for transmitter characteristics 55

A.3.3 Test condition for receiver characteristics 55

A.3.4 Test condition for performance requirements 56

Annex B (normative): Downlink physical channels 57

B.1 General 57

B.2 Set-up 57

B.3 Connection 57

B.3.1 Measurement of Receiver Characteristics 57

B.3.2 Measurement of Performance requirements 58

B.3.3 Measurement of Receiver Characteristics for Narrowband IoT 59

Annex C (normative): Environment conditions 60

C.1 General 60

C.2 Environmental 60

C.2.1 Temperature 60

C.2.2 Voltage 60

C.2.3 Vibration 61

Annex D (normative): Propagation conditions 62

D.1 Multi-path fading propagation conditions 62

D.1.1 Delay profiles 62

D.1.2 Combinations of channel model parameters 62

Annex E (informative): Change history 64

# Foreword

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

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

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

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 establishes the minimum RF characteristics and minimum performance requirements for E-UTRA User Equipment (UE) operating satellite access.

# 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 36.108: "Evolved Universal Terrestrial Radio Access (E-UTRA); Satellite Access Node (SAN) radio transmission and reception".

[3] 3GPP TS 36.211: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Channels and Modulation".

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

[5] 3GPP TS 36.307: "Evolved Universal Terrestrial Radio Access (E-UTRA); Requirements on User Equipments (UEs) supporting a release-independent frequency band".

[6] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification".

[7] 3GPP TS 36.101: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception"

[8] 3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2".

[9] ITU-R Recommendation SM.329-10, "Unwanted emissions in the spurious domain"

[10] [ANSI C63.26-2015, American National standard for Compliance Testing of Transmitters Used in Licensed Radio Services, Accredited Standards Committee C63 – Electromagnetic compatibility]

[11] 3GPP TS 36.306: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio access capabilities".

[12] 3GPP TS 36.213: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures".

[13] 3GPP TR 38.811: "Study on New Radio (NR) to support non-terrestrial networks"

[14] 3GPP TS 36.508: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Packet Core (EPC); Common test environments for User Equipment (UE) conformance testing".

# 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].

**Channel edge:** The lowest and highest frequency of the carrier, separated by the channel bandwidth.

**Channel bandwidth:** The RF bandwidth supporting a single E-UTRA RF carrier with the transmission bandwidth configured in the uplink or downlink of a cell. The channel bandwidth is measured in MHz and is used as a reference for transmitter and receiver RF requirements.

**Category NB1/NB2 stand-alone operation**: category NB1/NB2 is operating standalone when it utilizes its own spectrum, for example the spectrum used by GERAN systems as a replacement of one or more GSM carriers, as well as scattered spectrum for potential IoT deployment.

**Category NB1/NB2** **guard band operation:** category NB1/NB2 is operating in guard band when it utilizes the unused resource block(s) within a E-UTRA carrier’s guard-band.

**Category NB1/NB2** **in-band operation:** category NB1/NB2 is operating in-band when it utilizes the resource block(s) within a normal E-UTRA carrier or within a normal NR carrier plus 15 kHz at each edge (and not within NR minimum guard band).

**Geosynchronous Earth Orbit:** Earth-centred orbit at approximately 35786 kilometres above Earth's surface and synchronised with Earth's rotation. A geostationary orbit is a non-inclined geosynchronous orbit, i.e. in the Earth’s equator plane.

**Low Earth Orbit:** Orbit around the Earth with an altitude between 300 km, and 1500 km.

**Satellite:** A space-borne vehicle embarking a bent pipe payload or a regenerative payload telecommunication transmitter, placed into Low-Earth Orbit (LEO), Medium-Earth Orbit (MEO), or Geosynchronous Earth Orbit (GEO).

**Satellite Access Node:** see definition in TS 36.108 [2].

**sTTI**: A transmission time interval (TTI) of either one slot or one subslot as defined in TS 36.211 [3] on either uplink or downlink.

## 3.2 Symbols

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

ΔFRaster Band dependent channel raster granularity

BWChannel Channel bandwidth

F Frequency

FInterferer (offset) Frequency offset of the interferer (between the center frequency of the interferer and the carrier frequency of the carrier measured)

FInterferer Frequency of the interferer

FIoffset Frequency offset of the interferer (between the center frequency of the interferer and the closest edge of the carrier measured)

FC Frequency of the carrier centre frequency

FDL\_low The lowest frequency of the downlink operating band

FDL\_high The highest frequency of the downlink operating band

FUL\_low The lowest frequency of the uplink operating band

FUL\_high The highest frequency of the uplink operating band

FOOB The boundary between the E-UTRA out of band emission and spurious emission domains.

LCtone Transmission bandwidth which represents the length of a contiguous sub-carrier allocation expressed in units of tones

NDL Downlink EARFCN

NOffs-DL Offset used for calculating downlink EARFCN

NOffs-UL Offset used for calculating uplink EARFCN

NRB Transmission bandwidth configuration, expressed in units of resource blocks

NRB\_alloc Total number of simultaneously transmitted resource blocks in Channel bandwidth or Aggregated Channel Bandwidth.

Ntone Transmission bandwidth configuration for category NB1 and NB2, expressed in units of tones.

Ntone 3.75kHz Transmission bandwidth configuration for category NB1 and NB2 with 3.75 kHz sub-carrier spacing, expressed in units of tones.

Ntone 15kHz  Transmission bandwidth configuration for category NB1 and NB2 with 15 kHz sub-carrier spacing, expressed in units of tones.

NUL Uplink EARFCN.

PCMAX The configured maximum UE output power.

PInterferer Modulated mean power of the interferer

PPowerClass PPowerClass is the nominal UE power (i.e., no tolerance).

PPowerClass\_Default PPowerClass\_Default is the default nominal UE power (i.e., no tolerance) for the band.

PUMAX The measured configured maximum UE output power.

Puw Power of an unwanted DL signal

Pw Power of a wanted DL signal

ΔfOOB Δ Frequency of Out Of Band emission

## 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

A-MPR Additional Maximum Power Reduction

AWGN Additive White Gaussian Noise

BW Bandwidth

CW Continuous Wave

DL Downlink

EARFCN E-UTRA Absolute Radio Frequency Channel Number

E-UTRA Evolved UMTS Terrestrial Radio Access

EUTRAN Evolved UMTS Terrestrial Radio Access Network

EVM Error Vector Magnitude

FDD Frequency Division Duplex

GEO Geosynchronous Earth Orbit

GSO Geosynchronous Orbit

ITU-R Radiocommunication Sector of the International Telecommunication Union

LEO Low Earth Orbit

HD-FDD Half- Duplex FDD

MEO Medium Earth Orbit

MPR Maximum Power Reduction

NGSO Non-Geosynchronous Orbit

OCNG OFDMA Channel Noise Generator

OFDMA Orthogonal Frequency Division Multiple Access

OOB Out-of-band

QAM Quadrature Amplitude Modulation

RAN Radio Access Network

RE Resource Element

REFSENS Reference Sensitivity power level

RF Radio Frequency

UE User Equipment

UL Uplink

UMTS Universal Mobile Telecommunications System

UTRA UMTS Terrestrial Radio Access

UTRAN UMTS Terrestrial Radio Access Network

# 4 General

## 4.1 Relationship between minimum requirements and test requirements

The present document is a Single-RAT specification for satellite NR UE, covering RF characteristics and minimum performance requirements.

The Minimum Requirements given in this specification make no allowance for measurement uncertainty.

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

The shared risk principle is defined in Recommendation ITU‑R M.1545 [4].

## 4.2 Applicability of minimum requirements

a) Minimum requirements are mandated to be met in all scenarios by UEs supporting the applicable UE category(ies) for which that requirement is specified. In the present document, only minimum requirements for UE categories of M1, NB1, and NB2 are specified.

b) For UE category M1, the applicable minimum requirements in clauses 5, 6 or 7 are specified in the suffix A subclause where they differ from the requirements in the main subclause. Where suffix A does not exist for a requirement, the minimum requirement in the main subclause shall apply.

c) For UE category NB1 and NB2, the applicable minimum requirements in clauses 5, 6 or 7 are specified in the Suffix B subclause, where they differ from the requirements in the main subclause. Where suffix B does not exist for a requirement, the minimum requirement in the main subclause shall apply.

d) The reference sensitivity power levels defined in subclause 7.3 are valid for the specified reference measurement channels.

e) NOTE: Receiver sensitivity degradation may occur when:

1) The UE simultaneously transmits and receives with bandwidth allocations less than the transmission bandwidth configuration (see Figure 5.3A-1 and Figure 5.3B-1), and

2) Any part of the downlink transmission bandwidth is within an uplink transmission bandwidth from the downlink center subcarrier.

f) The spurious emissions power requirements are for the long-term average of the power. For the purpose of reducing measurement uncertainty it is acceptable to average the measured power over a period of time sufficient to reduce the uncertainty due to the statistical nature of the signal.

g) The requirements related to subslot TTI and/or slot TTI shall apply only if UE supports multiple TTI patterns. And these requirements only apply to subslot and/or slot TTI configurations

h) TS36.307 [5] specifies which minimum requirements in the present document are applicable to UEs that conform to an earlier specification Release, and from which Release those requirements apply.

## 4.3 Specification Suffix Information

The following suffixes are defined at 2nd level for clauses 5, 6 and 7, as shown in Table 4.3-1.

Table 4.3-1: Definition of suffixes

|  |  |
| --- | --- |
| Clause suffix | Variant |
| A | Cat-M1 |
| B | NB1, NB2 |

The suffixes shall apply as defined in clause 4.2.

# 5 Operating bands and channel arrangement

## 5.1 General

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

NOTE: Other operating bands and channel bandwidths may be considered in future releases.

## 5.2 Operating bands

E-UTRA satellite access is designed to operate in the operating bands defined in Table 5.2-1.

Table 5.2-1 E-UTRA operating bands for satellite access

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| E‑UTRA Operating Band | Uplink (UL) operating band BS receive UE transmit | | | Downlink (DL) operating band BS transmit  UE receive | | | Duplex Mode |
| FUL\_low – FUL\_high | | | FDL\_low – FDL\_high | | |
| 256 | 1980 MHz | – | 2010 MHz | 2170 MHz | – | 2200 MHz | FDD |
| 255 | 1626.5 MHz | – | 1660.5 MHz | 1525 MHz | – | 1559 MHz | FDD |
| 254 | 1610 MHz | - | 1626.5 MHz | 2483.5 MHz | - | 2500 MHz | FDD |
| 2532 | 1668 MHz | - | 1675 MHz | 1518 MHz | - | 1525 MHz | FDD |
| NOTE 1: Satellite bands are numbered in descending order from 256  NOTE 2: UE assigned to channels and allocated frequency resources in the lower portion of Band 253 may experience blocking or harmful interference from terrestrial networks in adjacent or nearby frequencies when operating in the proximity with terrestrial base stations. | | | | | | | |

## 5.2A Operating bands for UE category M1

UE category M1 is designed to operate in the E-UTRA satellite access operating bands defined in Table 5.2-1 in both half duplex FDD mode and full-duplex FDD mode.

## 5.2B Operating bands for category NB1 and NB2

Category NB1 and NB2 UE are designed to operate in the E-UTRA satellite access operating bands defined in Table 5.2-1.

Category NB1 and NB2 UE operate in HD-FDD duplex mode.

For operation in Band 255 in USA and Canada when NS\_02N is signalled, only channels positions which guarantee at least 90 kHz guard band from RF channel edge to the lower and upper limit of the band shall be used.

For operation in Band 254 in USA and Canada when NS\_03N is signalled, only channels positions which guarantee at least 90 kHz guard band from RF channel edge to the lower and upper limit of the band shall be used.

## 5.3 Channel bandwidth

This clause is reserved.

## 5.3A Channel bandwidth for category M1

The requirements in present document are specified for the channel bandwidth listed in Table 5.3A-1.

Table 5.3A-1: Transmission bandwidth configuration NRB in E-UTRA channel bandwidths

|  |  |
| --- | --- |
| Channel bandwidth BWChannel [MHz] | 1.4 |
| Transmission bandwidth configuration NRB | 6 |

Figure 5.3A-1 shows the relation between the Channel bandwidth (BWChannel) and the Transmission bandwidth configuration (NRB). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at FC +/- BWChannel /2.

Transmission

Center subcarrier (corresponds to DC in baseband) is not transmitted in downlink

Active Resource Blocks





Resource block

Transmission bandwidth configuration [NRB]

bandwidth [RB]

Channel bandwidth [MHz]

Figure 5.3A-1: Definition of channel bandwidth and transmission bandwidth configuration for one E‑UTRA carrier

## 5.3B Channel bandwidth for category NB1 and NB2

For category NB1 and NB2, requirements in present document are specified for the channel bandwidth listed in Table 5.3B-1.

Table 5.3B-1: Transmission bandwidth configuration *N*RB, *N*tone 15kHz and *N*tone 3.75kHz in NB1 and NB2 channel bandwidth

|  |  |
| --- | --- |
| Channel bandwidth BWChannel [kHz] | 200 |
| Transmission bandwidth configuration *N*RB | 1 |
| Transmission bandwidth configuration *N*tone 15kHz | 12 |
| Transmission bandwidth configuration *N*tone 3.75kHz | 48 |

Figure 5.3B-1 shows the relation between the Category NB1/NB2 channel bandwidth (BWChannel) and the Category NB1 /NB2 transmission bandwidth configuration (Ntone). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at FC +/- BWChannel /2.

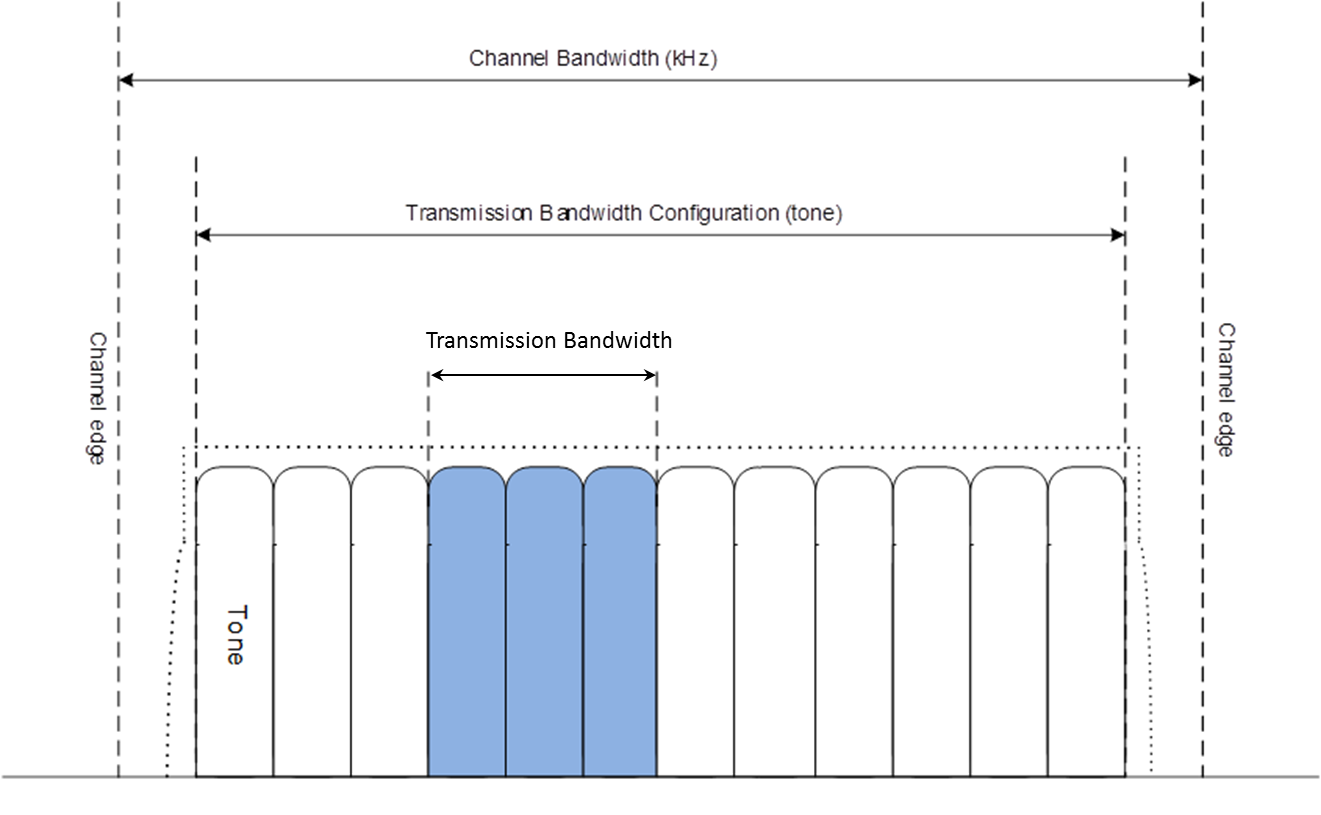


Figure 5.3B-1 Definition of Channel Bandwidth and Transmission Bandwidth configuration

## 5.4 Channel arrangement

This clause is reserved.

## 5.4A Channel arrangement for category M1

### 5.4A.1 Channel spacing

The spacing between carriers will depend on the deployment scenario, the size of the frequency block available and the channel bandwidths. The nominal channel spacing between two adjacent E-UTRA carriers is defined as following:

Nominal Channel spacing = (BWChannel(1) + BWChannel(2))/2

where BWChannel(1) and BWChannel(2) are the channel bandwidths of the two respective E-UTRA carriers. The channel spacing can be adjusted to optimize performance in a particular deployment scenario.

### 5.4A.2 Channel raster, carrier frequency and EARFCN

The global frequency raster is defined for all frequencies. The granularity of the global frequency raster is 100 kHz, which means that the carrier centre frequency must be an integer multiple of 100 kHz. For each operating band, a subset of frequencies from the global frequency raster are applicable and forms a channel raster with a granularity ΔFRaster.

The carrier frequency in the uplink and downlink is designated by the E-UTRA Absolute Radio Frequency Channel Number (EARFCN) in the range 0 – 262143. The relation between EARFCN and the carrier frequency in MHz for the downlink is given by the following equation, where FDL\_low and NOffs-DL are given in Table 5.4A.2-1 and NDL is the downlink EARFCN.

FDL = FDL\_low + 0.1(NDL – NOffs-DL)

The relation between EARFCN and the carrier frequency in MHz for the uplink is given by the following equation where FUL\_low and NOffs-UL are given in Table 5.4.2-1 and NUL is the uplink EARFCN.

FUL = FUL\_low + 0.1(NUL – NOffs-UL)

The applicable channel raster and EARFCNs for each operating band are specified in Table 5.4A.2-1.

For operating bands with a channel raster of 100 kHz, every EARFCN within the operating band shall be applicable for the channel raster, and the step size for the channel raster in Table 5.4A.2‑1 is given as <1>. The broadcast parameter *earfcn-LSB* defined in TS36.331 [6] may be used to assist the UE in synchronizing to the cell.

Table 5.4A.2-1: E-UTRA channel numbers

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA Operating  Band | ΔFRaster (kHz) | Downlink | | | Uplink | | |
| FDL\_low (MHz) | NOffs-DL | Range of NDL  (First – <Step size> – Last) | FUL\_low (MHz) | NOffs-UL | Range of NUL  (First – <Step size> – Last) |
| 256 | 100 | 2170 | 229076 | 229076 –<1>- 229375 | 1980 | 261844 | 261844 –<1>- 262143 |
| 255 | 100 | 1525 | 228736 | 228736 –<1>- 229075 | 1626.5 | 261504 | 261504 –<1>- 261843 |
| 254 | 100 | 2483.5 | 228571 | 228571 –<1>- 228735 | 1610 | 261339 | 261339 –<1>- 261503 |
| 253 | 100 | 1518 | 228501 | 228501-<1>-228570 | 1668 | 261269 | 261269-<1>-261338 |
| NOTE 1: The channel numbers that designate carrier frequencies so close to the operating band edges that the carrier extends beyond the operating band edge shall not be used. This implies that the first 7 channel numbers at the lower operating band edge and the last 6 channel numbers at the upper operating band edge shall not be used for channel bandwidth of 1.4 MHz. | | | | | | | |

### 5.4A.3 TX–RX frequency separation

The default E-UTRA TX channel (carrier centre frequency) to RX channel (carrier centre frequency) separation is specified in Table 5.4A.3-1 for the TX and RX channel bandwidth defined in Table 5.3A-1.

Table 5.4A.3-1: Default UE TX-RX frequency separation

| E-UTRA Operating Band | TX – RX  carrier centre frequency separation |
| --- | --- |
| 256 | 190 MHz |
| 255 | -101.5 MHz |
| 254 | 873.5 MHz |
| 253 | -150 MHz |

## 5.4B Channel arrangement for category NB1 and NB2

### 5.4B.1 Channel spacing

Nominal channel spacing for UE category NB1 and NB2 in stand-alone mode is 200 kHz.

### 5.4B.2 Channel raster, carrier frequency and EARFCN

The channel raster of UE category NB1/NB2 shall be as defined in clause 5.4A.2, and the channel raster per-frequency band shall be as defined in table 5.4A.2-1.

The carrier frequency of UE category NB1/NB2 in the downlink is designated by the E-UTRA Absolute Radio Frequency Channel Number (EARFCN) as defined in Table 5.4A.2-1, and the Offset of category NB1/NB2 Channel Number to EARFCN in the range of {-10, -9, -8, -7, -6, -5, -4, -3, -2, -1, -0.5, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9} for FDD. The relation between EARFCN, Offset of category NB1/NB2 Channel Number to EARFCN and the carrier frequency in MHz for the downlink is given by the following equation, where FDL is the downlink carrier frequency of category NB1/NB2, FDL\_low and NOffs-DL are given in table 5.4A.2-1, NDL is the downlink EARFCN, MDL is the Offset of category NB1/NB2 Channel Number to downlink EARFCN.

FDL = FDL\_low + 0.1(NDL – NOffs-DL) + 0.0025\*(2MDL)

The carrier frequency of UE category NB1/NB2 in the uplink is designated by the E-UTRA Absolute Radio Frequency Channel Number (EARFCN) as defined in Table 5.4A.2-1, and the Offset of category NB1/NB2 Channel Number to EARFCN in the range of {-10, -9, -8, -7, -6, -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9} for FDD. The relation between EARFCN, Offset of category NB1/NB2 Channel Number to EARFCN and the carrier frequency in MHz for the uplink is given by the following equation, where FUL is the uplink carrier frequency of category NB1/NB2, FUL\_low and NOffs-UL are given in table 5.4A.2-1, NUL is the uplink EARFCN, MUL is the Offset of category NB1/NB2 Channel Number to uplink EARFCN.

FUL = FUL\_low + 0.1(NUL – NOffs-UL) + 0.0025\*(2MUL)

NOTE 1: Guard-band operation and in-band operation for NB-IoT are not supported in this version of the specification.

NOTE 2: For the carrier including NPSS/NSSS for stand-alone operation, MDL = 0.

### 5.4B.3 TX–RX frequency separation

For UE category NB1/NB2 operation in stand-alone mode, the default TX-RX frequency separation shall be as specified in Table 5.4A.3-1 for the NB-IoT TX and RX channel bandwidth defined in Table 5.3B-1.

# 6 Transmitter characteristics

## 6.1 General

Unless otherwise stated, the transmitter characteristics are specified at the antenna connector of the UE with a single or multiple transmit antenna(s). For UE with integral antenna only, a reference antenna with a gain of 0 dBi is assumed.

All requirements in this section are applicable to devices supporting GSO and/or NGSO satellites.

## 6.2 Transmit power

This clause is reserved.

## 6.2A Transmit power for category M1

### 6.2A.1 UE maximum output power for category M1

The following UE Power Classes define the maximum output power for any transmission bandwidth within the channel bandwidth. The period of measurement shall be at least one sub frame (1ms).

Table 6.2A.1-1: UE Power Class

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| EUTRA band | Class 2  (dBm) | Tolerance  (dB) | Class 3 (dBm) | Tolerance (dB) | Class 5 (dBm) | Tolerance (dB) |
| 256 |  |  | 23 | +/-2 | 20 | +/-2 |
| 255 |  |  | 23 | +/-2 | 20 | +/-2 |
| 254 |  |  | 23 | +/-2 | 20 | +/-2 |
| 253 |  |  | 23 | +/-2 | 20 | +/-2 |
| NOTE 1: PPowerClass is the maximum UE power specified without taking into account the tolerance. | | | | | | |

The period of measurement shall be at least as defined in Table 6.2A.1-2.

Table 6.2A.1-2: Measurement period for UE maximum output power

|  |  |
| --- | --- |
| TTI pattern | Minimum measurement period |
| Subframe | 1ms |
| Slot | 7OS |
| Subslot | 2OS, 3OS |

The default power class PPowerClass\_Default for an operating band is Power Class 3 unless otherwise stated.

### 6.2A.2 UE maximum output power reduction for category M1

For category M1 UE Power Class 3 and 5, the allowed Maximum Power Reduction (MPR) for the maximum output power specified in Table 6.2A.1-1 due to higher order modulation and transmit bandwidth configuration (resource blocks) is specified in Table 6.2A.2-1.

For subPRB allocation of category M1 UE of Power Class 3, no MPR applies.

Table 6.2A.2-1: Maximum Power Reduction (MPR) for category M1 UE for Power Class 3 and 5

|  |  |  |
| --- | --- | --- |
| Modulation | Channel bandwidth / Transmission bandwidth (NRB) | MPR (dB) |
| 1.4 MHz |
| QPSK | > 2 | ≤ 1 |
| QPSK | > 5 | ≤ 2 |
| 16 QAM | ≤ 2 | ≤ 1 |
| 16 QAM | >2 | ≤ 2 |
| NOTE: MPR only applicable for NRB ≥ 1 | | |

For PRACH, PUCCH and SRS transmissions, the allowed MPR is according to that specified for PUSCH QPSK modulation for the corresponding transmission bandwidth.

For each subframe, the MPR is evaluated per slot and given by the maximum value taken over the transmission(s) within the slot; the maximum MPR over the two slots is then applied for the entire subframe.

For the UE maximum output power modified by MPR, the power limits specified in subclause 6.2A.4 apply.

### 6.2A.3 UE additional maximum output power reduction for category M1 UE

Additional ACLR and spectrum emission requirements can be signalled by the network to indicate that the UE shall also meet additional requirements in a specific deployment scenario. To meet these additional requirements, Additional Maximum Power Reduction (A-MPR) is allowed for the output power as specified in Table 6.2A.1-1. Unless stated otherwise, an A-MPR of 0 dB shall be used.

For UE Power Class 3 and 5 the specific requirements and identified subclauses are specified in Table 6.2A.3-1 along with the allowed A-MPR values that may be used to meet these requirements. The allowed A-MPR values specified below in Table 6.2A.3-1 are in addition to the allowed MPR requirements specified in subclause 6.2A.2.

Table 6.2A.3-1: Additional Maximum Power Reduction (A-MPR) for category M1 UE

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Network Signalling value | Requirements (subclause) | E-UTRA Band | Resources Blocks (*N*RB) | A-MPR (dB) | |
| NS\_01 | 6.5A.4.2 | Table 5.2-1 | Table 5.3A-1 | N/A | |
| NS\_02N | 6.5A.4.4.2 | 255 | Table 5.3A-1 | N/A | |
| NS\_03N | 6.5A.4.4.4 | 254 | Table 5.3A-1 | N/A | |
| NS\_04N | 6.5A.4.4.5 | 254 | Table 5.3A-1 | N/A | |
| NS\_05N | 6.5A.4.4.6 | 254 | Table 5.3A-1 | N/A | |
| NS\_24 | 6.5A.4.4.3 | 256 | Table 5.3A-1 | PC3 | PC5 |
| ≤ 3.5 | ≤ 0.5 |

For subPRB allocation, the allowed A-MPR values specified below in Table 6.2A.3-2 for category M1 UE are in addition to the allowed MPR requirements specified in subclause 6.2A.2.

Table 6.2A.3-2: Additional Maximum Power Reduction (A-MPR) for category M1 UE for subPRB allocation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Network Signalling value | Requirements (subclause) | E-UTRA Band | A-MPR (dB) | |
| NS\_01 | 6.5A.4.2 | Table 5.2-1 | N/A | |
| NS\_02N | 6.5A.4.4.2 | 255 | N/A | |
| NS\_03N | 6.5A.4.4.4 | 254 | N/A | |
| NS\_04N | 6.5A.4.4.5 | 254 | N/A | |
| NS\_05N | 6.5A.4.4.6 | 254 | N/A | |
| NS\_24 | 6.5A.4.4.3 | 256 | PC3 | PC5 |
| ≤ 3.5 | ≤ 0.5 |

### 6.2A.4 Configured transmitted Power for category M1

The configured transmitted power requirements in clause 6.2.5 of TS 36.101 [7] shall apply, wherein

- The Maximum output power requirements are specified in subclause 6.2A.1

- The MPR requirements are specified in subclause 6.2A.2

- The A-MPR requirements are specified in subclause 6.2A.3.

## 6.2B Transmit power for category NB1 and NB2

### 6.2B.1 UE maximum output power for category NB1 and NB2

Category NB1 and NB2 UE Power Classes are specified in Table 6.2B.1-1 and define the maximum output power for any transmission bandwidth within the category NB1 and NB2 channel bandwidth. For 3.75 kHz sub-carrier spacing the maximum output power is defined as mean power of measurement which period is at least one slot (2ms) excluding the 2304Ts gap when UE is not transmitting. For 15kHz sub-carrier spacing the maximum output power is defined as mean power of measurement which period is at least one sub-frame (1ms).

Table 6.2B.1-1: UE Power Class

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| EUTRA band | Class 3 (dBm) | Tolerance (dB) | Class 5 (dBm) | Tolerance (dB) |
| 256 | 23 | +/-2 | 20 | +/-2 |
| 255 | 23 | +/-2 | 20 | +/-2 |
| 254 | 23 | +/-2 | 20 | +/-2 |
| 253 | 23 | +/-2 | 20 | +/-2 |

The default power class PPowerClass\_Default for an operating band is Power Class 3 unless otherwise stated.

### 6.2B.2 UE maximum output power reduction for category NB1 and NB2

For UE category NB1 and NB2 power class 3 and 5 the allowed Maximum Power Reduction (MPR) for the maximum output power given in Table 6.2B.1-1 is specified in Table 6.2B.2-1.

Table 6.2B.2-1: Maximum Power Reduction (MPR) for UE category NB1 and NB2 Power Class 3 and 5

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Modulation | QPSK | | | |
| Tone positions for 3 Tones allocation | 0-2 | 3-5 and 6-8 | | 9-11 |
| MPR | ≤ 0.5 dB | 0 dB | | ≤ 0.5 dB |
| Tone positions for 6 Tones allocation | 0-5 and 6-11 | | | |
| MPR | ≤ 1 dB | | ≤ 1 dB | |
| Tone positions for 12 Tones allocation | 0-11 | | | |
| MPR | ≤ 2 dB | | | |

For the UE maximum output power modified by MPR, the power limits specified in sub-clause 6.2B.4 apply.

### 6.2B.3 UE additional maximum output power reduction for category NB1 and NB2 UE

Additional ACLR and spectrum emission requirements can be signalled by the network to indicate that the UE shall also meet additional requirements in a specific deployment scenario. To meet these additional requirements, Additional Maximum Power Reduction (A-MPR) is allowed for the output power are specified. For the agreed E-UTRA bands for category NB1 and NB2 UE an A-MPR of 0 dB shall be allowed unless specified otherwise.

For UE Power Class 3 and 5 the specific requirements and identified subclauses are specified in Table 6.2B.3-1 along with the allowed A-MPR values that may be used to meet these requirements. The allowed A-MPR values specified below in Table 6.2B.3-1 are in addition to the allowed MPR requirements specified in subclause 6.2B.2-1.

Table 6.2B.3-1: Additional Maximum Power Reduction (A-MPR) for category NB1 and NB2 UE

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Network Signalling value | Requirements (subclause) | E-UTRA Band | A-MPR (dB) | |
| NS\_01 | 6.5B.4.2 | Table 5.2-1 | N/A | |
| NS\_02N | 6.5B.4.4.2 | 255 | N/A | |
| NS\_03N | 6.5B.4.4.4 | 254 | N/A | |
| NS\_04N | 6.5B.4.4.5 | 254 | TBD | |
| NS\_05N | 6.5B.4.4.6 | 254 | TBD | |
| NS\_24 | 6.5B.4.4.3 | 256 | PC3 | PC5 |
| ≤ 3.5 | ≤ 0.5 |

### 6.2B.4 Configured transmitted Power for category NB1 and NB2

For category NB1 and NB2 UE, the configured transmitted power requirements in clause 6.2.5F of TS 36.101 [7] shall apply, wherein

- The Maximum output power requirements are specified in subclause 6.2B.1

- The MPR requirements are specified in subclause 6.2B.2

- The A-MPR requirements are specified in subclause 6.2B.3.

## 6.3 Output power dynamics

This clause is reserved.

## 6.3A Output power dynamics for category M1

### 6.3A.1 UE Minimum output power for category M1

The minimum controlled output power of the UE is defined as the broadband transmit power of the UE, i.e. the power in the channel bandwidth for all transmit bandwidth configurations (resource blocks), when the power is set to a minimum value.

The minimum output power is defined as the mean power in one sub-frame (1ms). The minimum output power shall not exceed the values specified in Table 6.3.2.1-1 of TS 36.101 [7].

### 6.3A.2 Transmit OFF power for category M1

Transmit OFF power is defined as the mean power when the transmitter is OFF. The transmitter is considered to be OFF when the UE is not allowed to transmit or during periods when the UE is not transmitting a sub-frame. During DTX and measurements gaps, the UE is not considered to be OFF.

The transmit OFF power is defined as the mean power in a duration of at least one sub-frame (1ms) excluding any transient periods. The transmit OFF power shall not exceed the values specified in Table 6.3.3.1-1 of TS 36.101 [7].

### 6.3A.3 ON/OFF time mask for category M1

The requirements for transmit ON/OFF time mask defined in clause 6.3.4 of TS 36.101 [7] shall apply.

### 6.3A.4 Power control for category M1

For category M1 UE, the requirements in clause 6.3.5E of TS 36.101 [7] shall apply, wherein

- The Maximum output power requirements are specified in subclause 6.2A.1

- The Minimum output power requirements are specified in subclause 6.3A.1.

- The requirements for configured transmitted power are specified in subclause 6.2A.4.

## 6.3B Output power dynamics for category NB1 and NB2

### 6.3B.1 UE Minimum output power for category NB1 and NB2

For category NB1 and NB2 UE, the requirements in clause 6.3.2F of TS 36.101 [7] shall apply.

### 6.3B.2 Transmit OFF power for category NB1 and NB2

For category NB1 and NB2 UE, the requirements in clause 6.3.3F of TS 36.101 [7] shall apply.

### 6.3B.3 ON/OFF time mask for category NB1 and NB2

For category NB1 and NB2 UE, the requirements in clause 6.3.4F of TS 36.101 [7] shall apply.

### 6.3B.4 Power Control for category NB1 and NB2

For category NB1 and NB2 UE, the requirements in clause 6.3.5F of TS 36.101 [7] shall apply, wherein

- The Maximum output power requirements are specified in subclause 6.2B.1

- The Minimum output power requirements are specified in subclause 6.3B.1

- The requirements for configured transmitted power are specified in subclause 6.2B.4.

## 6.4 Transmit signal quality

This clause is reserved.

## 6.4A Transmit signal quality for category M1

### 6.4A.1 Frequency error for UE category M1

For category M1 UE, the basic measurement interval of modulated carrier frequency is 1 UL timeslot (0.5ms). The UE pre-compensates the uplink modulated carrier frequency by the estimated Doppler shift based on received ephemeris information of the SAN in IE EphemerisInfo (TS 36.331 [6]), its own location and UL carrier frequency signalled to the UE by the SAN (according to TS36.300 [8] clause 16.14.2).

For category M1 FD-FDD UEs and for category M1 HD-FDD UEs with continuous uplink transmissions of duration ≤ 64 ms, the mean value of basic measurements of UE pre-compensated modulated carrier frequency shall be accurate to within ± 0.1 PPM observed over a period of one time slot (0.5 ms) compared with the ideally pre-compensated UL carrier frequency.

For category M1 HD-FDD UEs with continuous uplink transmissions of duration > 64 ms, the mean value of basic measurements of UE pre-compensated modulated carrier frequency shall be accurate within the limits in Table 6.4A.1-1 observed over a period of one time slot (0.5 ms) compared with ideally pre-compensated UL carrier frequency.

When a repetition period is configured on the uplink for which repetition period (R ) >1, the UE shall not change Doppler pre-compensation during an ongoing repetition period, except in the transmission gaps as defined in clause 10.1.3.6 of TS 36.211[3]. When segmentation is applied, then the UE shall update pre-compensation at the beginning of each segment prior to segment transmission.

NOTE: The ideally pre-compensated reference uplink carrier frequency consists of the UL carrier frequency signalled to the UE by SAN and UL pre-compensated Doppler frequency shift corresponding to the estimated Doppler frequency at the beginning of the transmission.]

Table 6.4A.1-1: Frequency error requirement for HD-FDD UE category M1

|  |  |
| --- | --- |
| Carrier frequency [GHz] | Frequency error [ppm] |
| ≤1 | ±0.2 |
| >1 | ±0.1 |

### 6.4A.2 Transmit modulation quality for category M1

Transmit modulation quality defines the modulation quality for expected in-channel RF transmissions from the UE. The transmit modulation quality is specified in terms of:

- Error Vector Magnitude (EVM) for the allocated resource blocks (RBs)

- EVM equalizer spectrum flatness derived from the equalizer coefficients generated by the EVM measurement process

- Carrier leakage

- In-band emissions for the non-allocated RB

All the parameters defined in subclause 6.4A.2 are defined using the measurement methodology specified in clause Annex F of TS 36.101 [7].

For category M1 UE, the requirements in clause 6.5.2E of TS 36.101 [7] shall apply, and only QPSK and 16QAM in UL shall be applicable.

## 6.4B Transmit signal quality for category NB1 and NB2

### 6.4B.1 Frequency error for UE category NB1 and NB2

For UE category NB1 and NB2, the UE pre-compensates the uplink modulated carrier frequency by the estimated Doppler shift based on received ephemeris information of the SAN in IE *EphemerisInfo* (TS 36.331 [6]), its own location and UL carrier frequency signalled to the UE by the SAN (according to TS36.300 [8] clause 23.21.2.2).

The UE pre-compensated modulated carrier frequency shall be accurate to within the limits in Table 6.4B.1-1, observed over a period of one time slot (0.5 ms for 15 kHz sub-carrier spacing and 2 ms excluding the 2304Ts gap for 3.75 kHz sub-carrier spacing) and averaged over 72/LCtone slots (where LCtone = {1, 3, 6, 12} is the number of sub-carriers used for the transmission), compared to the ideally pre-compensated reference uplink carrier frequency.

When a repetition period is configured on the uplink for which repetition period (R ) >1, the UE shall not change Doppler pre-compensation during an ongoing repetition period, except in the transmission gaps as defined in clause 10.1.3.6 of TS 36.211[3]. When segmentation is applied, then the UE shall update pre-compensation at the beginning of each segment prior to segment transmission.

[NOTE: The ideally pre-compensated reference uplink carrier frequency consists of the UL carrier frequency signalled to the UE by SAN and UL pre-compensated Doppler frequency shift corresponding to the estimated Doppler frequency at the beginning of the transmission.]

Table 6.4B.1-1: Frequency error requirement for UE category NB1 and NB2

|  |  |
| --- | --- |
| Carrier frequency [GHz] | Frequency error [ppm] |
| ≤1 | ±0.2 |
| >1 | ±0.1 |

### 6.4B.2 Transmit modulation quality for Category NB1 and NB2

Transmit modulation quality requirements for Category NB1 and NB2 UEs for BPSK and QPSK modulation as specified in clause 6.5.2F of 36.101 [7] are applicable.

## 6.5 Output RF spectrum emissions

The output UE transmitter spectrum consists of the three components; the emission within the occupied bandwidth (channel bandwidth), the Out Of Band (OOB) emissions and the far out spurious emission domain.

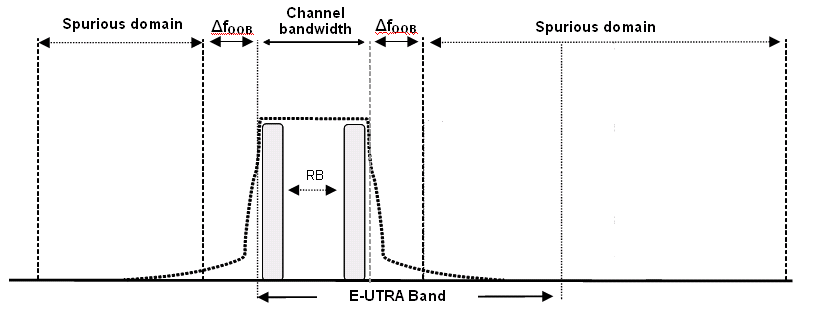


Figure 6.5-1: Transmitter RF spectrum

## 6.5A Output RF spectrum emissions for category M1

### 6.5A.1 General

The definitions in clause 6.5 shall apply.

When the UE is operating in an NGSO deployment, to support coexistence, it is assumed that a guardband at least equivalent to the maximum doppler shift expected for the NGSO constellation between the channel edge of the channel bandwidth operated by the UE and the spectrum block edge has been accounted for as part of system deployment configuration by the operator.

### 6.5A.2 Occupied bandwidth for category M1

Occupied bandwidth is defined as the bandwidth containing 99 % of the total integrated mean power of the transmitted spectrum on the assigned channel. The occupied bandwidth for all transmission bandwidth configurations (Resources Blocks) shall be less than the 1.4MHz channel bandwidth specified in Table 6.6.1-1 of TS 36.101 [7].

### 6.5A.3 Out of band emission for category M1

#### 6.5A.3.1 General

The out of band emissions are unwanted emissions immediately outside the assigned channel bandwidth resulting from the modulation process and non-linearity in the transmitter but excluding spurious emissions. This out of band emission limit is specified in terms of a spectrum emission mask and an Adjacent Channel Leakage power Ratio.

#### 6.5A.3.2 Spectrum emission mask

The spectrum emission mask of the UE applies to frequencies (ΔfOOB) starting from the ± edge of the assigned E-UTRA channel bandwidth. For frequencies offset greater than ΔfOOB as specified in Table 6.5A.3.2-1 the spurious requirements in subclause 6.5A.4 are applicable.

The power of any UE emission shall not exceed the levels specified in Table 6.5A.3.2-1 for the specified channel bandwidth.

Table 6.5A.3.2-1: Category M1 spectrum emission mask

|  |  |  |
| --- | --- | --- |
| ΔfOOB  (MHz) | 1.4  MHz | Measurement bandwidth |
| ± 0-1 | -10 | 30 kHz |
| ± 1-2.5 | -10 | 1 MHz |
| ± 2.5-2.8 | -25 | 1 MHz |

NOTE1: As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, 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.

#### 6.5A.3.3 Additional Spectrum Emission Mask for category M1

The additional spectrum emission mask is not applicable.

#### 6.5A.3.4 Adjacent Channel Leakage Ratio for category M1

E-UTRA category M1 Adjacent Channel Leakage power Ratio (E-UTRAACLR) 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 at nominal channel spacing. The assigned E-UTRA category M1 channel power and adjacent E-UTRA category M1 channel power are measured with rectangular filters with measurement bandwidths specified in Table 6.5A.3.4-1. If the measured adjacent channel power is greater than –50dBm then the E-UTRAACLR shall be higher than the value specified in Table 6.5A.3.4-1.

Table 6.5A.3.4-1: Category M1 ACLR requirements

|  |  |
| --- | --- |
|  | Channel bandwidth / E-UTRAACLR / Measurement bandwidth |
| 1.4  MHz |
| E-UTRAACLR | 30 dB |
| E-UTRA channel Measurement bandwidth | 1.08 MHz |
| Adjacent channel centre frequency offset [MHz] | +1.4/-1.4 |

### 6.5A.4 Spurious emission for category M1

#### 6.5A.4.1 General

Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emissions, intermodulation products and frequency conversion products, but exclude out of band emissions unless otherwise stated. The spurious emission limits are specified in terms of general requirements inline with SM.329 [9] and E-UTRA operating band requirement to address UE co-existence.

To improve measurement accuracy, sensitivity and efficiency, 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.

#### 6.5A.4.2 Minimum requirements

Unless otherwise stated, the spurious emission limits apply for the frequency ranges that are more than FOOB (MHz) in Table 6.5A.4.2-1 from the edge of the channel bandwidth. The spurious emission limits in Table 6.5A.4.2-2 apply for all transmitter band configurations (NRB) and channel bandwidths.

NOTE: For measurement conditions at the edge of each frequency range, the lowest frequency of the measurement position in each frequency range should be set at the lowest boundary of the frequency range plus MBW/2. The highest frequency of the measurement position in each frequency range should be set at the highest boundary of the frequency range minus MBW/2. MBW denotes the measurement bandwidth defined for the protected band.

Table 6.5A.4.2-1: Boundary between E-UTRA out of band and spurious emission domain

|  |  |
| --- | --- |
| Channel bandwidth | 1.4  MHz |
| OOB boundary FOOB (MHz) | 2.8 |

Table 6.5A.4.2-2: Spurious emissions limits

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency Range | Maximum Level | Measurement bandwidth | NOTE |
| 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 < 5th harmonic of the upper frequency edge of the UL operating band in GHz | -30 dBm | 1 MHz |  |

#### 6.5A.4.3 Spurious emission band UE co-existence

This clause specifies the requirements for E-UTRA satellite bands for UE coexistence with protected bands.

Table 6.5A.4.3-1: Requirements for spurious emissions for UE co-existence

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| E-UTRA Band | Spurious emission | | | | | | |
| Protected band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| 253 | E-UTRA Band 5, 26, 41, 48  NR Band n1, n3, n7, n8, n18, n20, n28, n34, n38, n39, n40, n50, n51, n65, n67, n74, n75, n76, n79, n91, n92, n93, n94 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| NR Band n77, n78 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| 254 | E-UTRA Band 2, 4, 5, 12, 13, 14, 17, 24, 25, 26, 29, 30, 31, 41, 48, 54, 66, 70, 71, 72, 85, 87, 88, 103  NR Band n1, n3, n7, n8, n18, n20, n28, n34, n38, n39, n40, n50, n51, n53, n54, n65, n67, n74, n75, n76, n77, n78, n90, n91, n92, n93, n94, n105 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| NR Band n79 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| 255 | E-UTRA Band 2, 4, 5, 12, 13, 14, 17, 24, 25, 26, 29, 30, 41, 48, 66, 70, 71, 85, 103  NR Band n1, n3, n7, n8, n18, n20, n28, n34, n38, n39, n40, n50, n51, n53, n65, n67, n74, n75, n76, n90, n91, n92, n93, n94 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| NR Band n77, n78, n79 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| 256 | E-UTRA Band 1, 3, 5,7, 8, 11, 18, 19, 20, 21, 22, 26, 27, 28, 31, 33, 32, 35, 38, 40, 41, 42, 43, 50, 51, 54, 65, 68, 69, 72, 74, 75, 76, 87, 88  NR Band n12, n13, n14, n24, n29, n30, n39, n48, n53, n66, n67, n71, n78, n79, n85, n90, n91, n92, n93, n94, n101 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| NR Band n77 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| NR Band n2, n25, n70 | FDL\_low | - | FDL\_high | NA | NA | 3 |
| NOTE 1: FDL\_low and FDL\_high refer to each E-UTRA frequency band specified in Table 5.4A.2-1  NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5A.4.2-2 are permitted for each assigned E-UTRA carrier used in the measurement due to 2nd, 3rd, 4th [or 5th] harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of (2MHz + N x LCRB x 180kHz), where N is 2, 3, 4, [5] for the 2nd, 3rd, 4th [or 5th] harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval.  NOTE 3: The co-existence between 256 and band 2, 25 and 70 is subject to regional/national regulation. | | | | | | | |

NOTE: To simplify Table 6.5A.4.3-1, E-UTRA band numbers are listed for bands which are specified only for E-UTRA operation or both E-UTRA and NR operation. NR band numbers are listed for bands which are specified only for NR operation.

#### 6.5A.4.4 Additional spurious emissions

##### 6.5A.4.4.1 General

These requirements are specified in terms of an additional spectrum emission requirement. Additional spurious emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

NOTE: In addition to the requirements below, additional UE region-specific emissions requirements for European are expected to be added once more information becomes available.

##### 6.5A.4.4.2 Minimum requirement (network signalled value "NS\_02N")

When "NS\_02N" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5A.4.4.2-1 and 6.5A.4.4.2-2. This requirement also applies for the frequency ranges that are less than FOOB (MHz) in Table 6.5A.4.2-1 from the edge of the channel bandwidth. Network signalling remark NS\_02N applies integer-value 2.

Table 6.5A.4.4.2-1: Additional requirements for "NS\_02N"

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency band  (MHz) | Channel bandwidth / Spectrum emission limit1 (dBm) | Measurement bandwidth | NOTE |
| 1.4MHz |
| 1559≤ f ≤ 1605 | -50 | 700 Hz | Averaged over any 2 millisecond active transmission interval |
| 1605≤ f ≤ 1610 | -50 + 24/5 (f-1605) | 700Hz |  |
| 1559 ≤ f ≤ 1605 | -40 | 1MHz | Averaged over any 2 millisecond active transmission interval |
| 1605≤ f ≤ 1610 | -40 + 24/5 (f-1605) | 1MHz |  |
| NOTE: The EIRP requirement in regulation is converted to conducted requirement using a 0 dBi antenna. | | | |

Table 6.5A.4.4.2-2: Additional requirements for "NS\_02N"

|  |  |  |
| --- | --- | --- |
| ΔfOOB  (MHz) | Spectrum Emission Limit (dBm) | Measurement bandwidth |
| 0 – 0.7 | -2 for PC3  -5 for PC5 | 4 kHz |
| 0.7 – 2.8 | -12 for PC3  -15 for PC5 | 4 kHz |
| >2.8 | -13 for PC3 and PC5 | 4 kHz |

##### 6.5A.4.4.3 Minimum requirement (network signalled value "NS\_24")

When "NS\_24" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5A.4.4.3-1.

Table 6.5A.4.4.3-1: Additional requirements for "NS\_24"

|  |  |  |
| --- | --- | --- |
| Frequency band  (MHz) | Channel bandwidth /  Spectrum emission limit  (dBm) | Measurement bandwidth |
| 1.4MHz |
| Band 34 | -50 | MHz |
| NOTE 1: This requirement applies at a frequency offset equal or larger than 5 MHz from the upper edge of the channel bandwidth, whenever these frequencies overlap with the specified frequency band. | | |

##### 6.5A.4.4.4 Minimum requirement (network signalled value "NS\_03N")

When "NS\_03N" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5A.4.4.4-1 where BWchannel equals to 1.4MHz. This requirement also applies for the frequency ranges that are less than FOOB (MHz) in Table 6.5A.4.2-1 from the edge of the channel bandwidth.

Table 6.5.4.4.4-1: Additional out-of-band requirements for "NS\_03N"

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency band  (MHz) | Channel bandwidth / Spectrum emission limit1 (dBm) | Measurement bandwidth | NOTE |
| BWchannel |
| 1559 ≤ f ≤ 1605 | -50 | 700 Hz | Discreet emissions averaged over any 2 millisecond active transmission interval |
| 1605 ≤ f ≤ 1610 | -50 + 60/5 (f-1605) | 700 Hz |
| 1559 ≤ f ≤ 1605 | -40 | 1MHz | Averaged over any 2 millisecond active transmission interval |
| 1605 ≤ f ≤ 1610 | -40 + 60/5 (f-1605) | 1MHz |
| NOTE: The EIRP requirement in regulation is converted to conducted requirement using a 0dBi antenna. | | | |

Table 6.5A.4.4.4-2: Additional requirements for "NS\_03N"

|  |  |  |
| --- | --- | --- |
| ΔfOOB  (MHz) | Spectrum Emission Limit (dBm) | Measurement bandwidth |
| 0 – 0.7 | -2 for PC3  -5 for PC5 | 4 kHz |
| 0.7 – 2.8 | -12 for PC3  -15 for PC5 | 4 kHz |
| >2.8 | -13 for PC3 and PC5 | 4 kHz |

##### 6.5A.4.4.5 Minimum requirement (network signalled value "NS\_04N")

When "NS\_04N" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5A.4.4.5-1 where BWchannel equals to 1.4MHz. This requirement also applies for the frequency ranges that are less than FOOB (MHz) in Table 6.5A.4.2-1 from the edge of the channel bandwidth.

Table 6.5A.4.4.5-1: Additional out-of-band requirements for "NS\_04N"

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency band  (MHz) | Channel bandwidth / Spectrum emission limit1 (dBm) | Measurement bandwidth | NOTE |
| BWchannel |
| 1559 ≤ f ≤ 1605 | -40 | 1MHz | Averaged over any 2 millisecond active transmission interval |
| 1605 ≤ f ≤ 1610 | -40 + 60/5 (f-1605) | 1MHz |
|  |  |  |  |
| 1628.5 ≤ f ≤ 1631.5 | -30 | 30kHz |  |
| 1631.5 ≤ f ≤ 1636.5 | -30 | 100kHz |  |
| 1636.5 ≤ f ≤ 1646.5 | -30 | 300kHz |  |
| 1646.5 ≤ f ≤ 1666.5 | -30 | 1MHz |  |
| 1666.5 ≤ f ≤ 2200 | -30 | 3MHz |  |
| NOTE: The EIRP requirement in regulation is converted to conducted requirement using a 0dBi antenna. | | | |

When "NS\_04N" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5A.4.4.5-2 for any carrier configured within 1610-1618.25MHz.

Table 6.5A.4.4.5-2: Additional in-band requirements for "NS\_04N"

|  |  |  |
| --- | --- | --- |
| ΔfOOB (kHz) | Spectrum emission limit (dBm) | Measurement bandwidth |
| ± 0-160 | -2 | 30kHz |
| ± 160-2300 | -2 to -26 |
| ± 2300-18500 | -26 |
| NOTE: Spectrum emissions are linearly interpolated in dBm versus frequency offset. | | |

##### 6.5A.4.4.6 Minimum requirement (network signalled value "NS\_05N")

When "NS\_05N" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in 6.5A.4.4.5-1 where BWchannel equals to 1.4MHz. This requirement also applies for the frequency ranges that are less than FOOB (MHz) in Table 6.5A.4.2-1 from the edge of the channel bandwidth.

When "NS\_05N" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5A.4.4.6-2 for any carrier configured within 1618.25-1626.5MHz.

Table 6.5A.4.4.6-1: void

Table 6.5A.4.4.6-2: Additional in-band requirements for "NS\_05N"

|  |  |  |
| --- | --- | --- |
| ΔfOOB (kHz) | Spectrum emission limit (dBm) | Measurement bandwidth |
| ± 0-160 | -5 | 30kHz |
| ± 160-225 | -5 to -8.5 |
| ± 225-650 | -8.5 to -15 |
| ± 650-1365 | -15 |
| ± 1365-1800 | -23 to -26 |
| ± 1800-16500 | -26 |
| NOTE: Spectrum emissions are linearly interpolated in dBm versus frequency offset. | | |

## 6.5B Output RF spectrum emissions for category NB1 and NB2

### 6.5B.1 General

The definitions in clause 6.5 shall apply.

### 6.5B.2 Occupied bandwidth for category NB1 and NB2

For category NB1 and NB2 UE, the requirements in clause 6.6.1F of TS 36.101 [7] shall apply.

### 6.5B.3 Out of band emission for category NB1 and NB2

#### 6.5B.3.1 General

The out of band emissions are unwanted emissions immediately outside the assigned channel bandwidth resulting from the modulation process and non-linearity in the transmitter but excluding spurious emissions. This out of band emission limit is specified in terms of a spectrum emission mask and an Adjacent Channel Leakage power Ratio.

#### 6.5B.3.2 Spectrum emission mask

The spectrum emission mask of the category NB1 and NB2 UE applies to frequencies (ΔfOOB) starting from the ± edge of the assigned category NB1 or NB2 channel bandwidth. For frequencies greater than (ΔfOOB) as specified in Table 6.5B.3.2-1 the spurious requirements in subclause 6.5B.4 are applicable.

The power of any category NB1 or NB2 UE emission shall not exceed the levels specified in Table 6.5B.3.2-1. The spectrum emission limit between each ΔfOOB is linearly interpolated.

Table 6.5B.3.2-1: Category NB1 and NB2 UE spectrum emission mask

|  |  |  |
| --- | --- | --- |
| ΔfOOB (kHz) | Emission limit (dBm) | Measurement bandwidth |
| ± 0 | 26 | 30 kHz |
| ± 100 | -5 | 30 kHz |
| ± 150 | -8 | 30 kHz |
| ± 300 | -29 | 30 kHz |
| ± 500-1700 | -35 | 30 kHz |

NOTE1: As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, 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.

[NOTE2: When the UE is operating in an NGSO deployment, to support coexistence, it is assumed that a guardband at least equivalent to the maximum doppler shift expected for the NGSO constellation between the channel edge of the channel bandwidth operated by the UE and the spectrum block edge has been accounted for as part of system deployment configuration by the operator.]

#### 6.5B.3.3 Additional Spectrum Emission Mask for category NB1 and NB2

The additional spectrum emission mask for category NB1 and NB2 is not applicable.

#### 6.5B.3.4 Adjacent Channel Leakage Ratio for category NB1 and NB2

Adjacent Channel Leakage power Ratio 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 assigned category NB1or NB2 channel power and adjacent channel power are measured with filters and measurement bandwidths specified in Table 6.5B.3.4-1. If the measured adjacent channel power is greater than –50dBm then the category NB1 or NB2 UE ACLR shall be higher than the value specified in Table 6.5B.3.4-1. GSMACLR requirement is intended for protection of GSM system. UTRAACLR requirement is intended for protection of UTRA and E-UTRA systems.

Table 6.5B.3.4-1: category NB1 and NB2 UE ACLR requirements

|  |  |  |
| --- | --- | --- |
|  | GSMACLR | UTRAACLR |
| ACLR | 20 dB | 37 dB |
| Adjacent channel  center frequency offset from category NB1 or NB2 Channel edge | ±200 kHz | ±2.5 MHz |
| Adjacent channel measurement bandwidth | 180 kHz | 3.84 MHz |
| Measurement filter | Rectangular | RRC-filter α=0.22 |
| Category NB1 and NB2 channel measurement bandwidth | 180 kHz | 180 kHz |
| Category NB1 and NB2 channel Measurement filter | Rectangular | Rectangular |

### 6.5B.4 Spurious emission for category NB1 and NB2

#### 6.5B.4.1 General

Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emissions, intermodulation products and frequency conversion products, but exclude out of band emissions unless otherwise stated. The spurious emission limits are specified in terms of general requirements inline with SM.329 [9] and E-UTRA operating band requirement to address UE co-existence.

To improve measurement accuracy, sensitivity and efficiency, 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.

#### 6.5B.4.2 Minimum requirements

When UE is configured for category NB1 or NB2 uplink transmissions the requirements in subclause 6.5A.4.2 apply with an exception that boundary between category NB1 or NB2 out of band and spurious emission domain shall be FOOB = 1.7 MHz.

#### 6.5B.4.3 Spurious emission band UE co-existence

The spurious emission band UE coexistence requirement in sub-clause 6.5A.4.3 is also applicable for NB1 and NB2 UE.

#### 6.5B.4.4 Additional spurious emissions

##### 6.5B.4.4.1 General

These requirements are specified in terms of an additional spectrum emission requirement. Additional spurious emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message.

NOTE: In addition to the requirements below, additional UE region-specific emissions requirements for European are expected to be added once more information becomes available.

##### 6.5B.4.4.2 Minimum requirement (network signalled value "NS\_02N")

When "NS\_02N" is indicated in the cell, the power of any UE spurious emission shall not exceed the levels specified in Table 6.5B.4.4.2-1 and 6.5B.4.4.2-2. This requirement also applies for the frequency ranges that are less than FOOB (MHz) specified in 6.5B.4.2 from the edge of the channel bandwidth. Network signalling remark NS\_02N applies integer-value 2.

Table 6.5B.4.4.2-1: Additional requirements for "NS\_02N"

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency band  (MHz) | Channel bandwidth / Spectrum emission limit1 (dBm) | Measurement bandwidth | NOTE |
| 200kHz |
| 1559≤ f ≤ 1605 | -50 | 700 Hz | Averaged over any 2 millisecond active transmission interval |
| 1605≤ f ≤ 1610 | -50 + 24/5 (f-1605) | 700Hz |  |
| 1559 ≤ f ≤ 1605 | -40 | 1MHz | Averaged over any 2 millisecond active transmission interval |
| 1605≤ f ≤ 1610 | -40 + 24/5 (f-1605) | 1MHz |  |
| NOTE: The EIRP requirement in regulation is converted to conducted requirement using a 0 dBi antenna. | | | |

Table 6.5B.4.4.2-2: Additional requirements for "NS\_02N"

|  |  |  |
| --- | --- | --- |
| ΔfOOB  (MHz) | Spectrum Emission Limit (dBm) | Measurement bandwidth |
|  [0.09 – 0.28] | -2 for PC3  -5 for PC5 | 4 kHz |
|  [0.28 – 0.85] | -12 for PC3  -15 for PC5 | 4 kHz |
|  [>0.85] | -13 for PC3 and PC5 | 4 kHz |

NOTE: ΔfOOB = 0.09 MHz corresponds to an authorized bandwidth, as defined in C63.26-2015 [10], of 0.38 MHz.

##### 6.5B.4.4.3 Minimum requirement (network signalled value "NS\_24")

When "NS\_24" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in Table 6.5B.4.4.3-1.

Table 6.5B.4.4.3-1: Additional requirements for "NS\_24"

|  |  |  |
| --- | --- | --- |
| Frequency band  (MHz) | Channel bandwidth /  Spectrum emission limit  (dBm) | Measurement bandwidth |
| 200kHz |
| Band 34 | -50 | MHz |
| NOTE 1:This requirement applies at a frequency offset equal or larger than 5 MHz from the upper edge of the channel bandwidth, whenever these frequencies overlap with the specified frequency band. | | |

##### 6.5B.4.4.4 Minimum requirement (network signalled value "NS\_03N")

When "NS\_03N" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in 6.5A.4.4.4 where BWchannel is replaced with 200 kHz, and FOOB (MHz) is replaced with 1.7MHz, in addition to the additional requirements specified in Table 6.5B.4.4.4-1.

Table 6.5B.4.4.4-1: Additional requirements for "NS\_03N"

|  |  |  |
| --- | --- | --- |
| ΔfOOB  (MHz) | Spectrum Emission Limit (dBm) | Measurement bandwidth |
|  [0.09 – 0.28] | -2 for PC3  -5 for PC5 | 4 kHz |
|  [0.28 – 0.85] | -12 for PC3  -15 for PC5 | 4 kHz |
|  [>0.85] | -13 for PC3 and PC5 | 4 kHz |

NOTE: ΔfOOB = 0.09 MHz corresponds to an authorized bandwidth, as defined in C63.26-2015 [10], of 0.38 MHz.

##### 6.5B.4.4.5 Minimum requirement (network signalled value "NS\_04N")

When "NS\_04N" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in 6.5A.4.4.5 where BWchannel is replaced with 200 kHz, and FOOB (MHz) is replaced with 1.7MHz.

##### 6.5B.4.4.6 Minimum requirement (network signalled value "NS\_05N")

When "NS\_05N" is indicated in the cell, the power of any UE emission shall not exceed the levels specified in 6.5A.4.4.6 where BWchannel is replaced with 200 kHz, and FOOB (MHz) is replaced with 1.7MHz.

## 6.6 Transmit intermodulation

This clause is reserved.

## 6.6A Transmit intermodulation for category M1

For category M1 UE, Tx intermodulation requirements are not applicable.

## 6.6B Transmit intermodulation for category NB1 and NB2

For category NB1 and NB2 UE, the Tx intermodulation requirements in clause 6.7.1F of TS 36.101 [7] shall apply.

# 7 Receiver characteristics

## 7.1 General

The requirements in clause 7.1 of TS 36.101 [7] shall apply.

All requirements in this section are applicable to devices supporting GSO and/or NGSO satellites.

## 7.2 Diversity characteristics

The requirements in clause 7 assume that the receiver is equipped with single Rx port.

## 7.3 Reference sensitivity power level

This clause is reserved.

## 7.3A Reference sensitivity power level for UE category M1

The reference sensitivity power level REFSENS is the minimum mean power applied to the single antenna port for UE category M1, at which the throughput shall meet or exceed the requirements for the specified reference measurement channel.

The throughput for the REFSENS test is measured based on the Transmission Mode 1 unless specified otherwise.

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes [A.2.2 and A.3.2] (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex [A.5.1.1]) with parameters specified in Table 7.3A-1 and Table 7.3A-2 for category M1.

Table 7.3A-1: Reference sensitivity for FDD UE category M1 QPSK PREFSENS

|  |  |  |
| --- | --- | --- |
| NTN Band | REFSENS (dBm) | Duplex Mode |
| 253 | -102.7 | FDD |
| 254 | -102.2 | FDD |
| 255 | -102.7 | FDD |
| 256 | -102.2 | FDD |
| NOTE 1: The transmitter shall be set to PUMAX as defined in subclause 6.2.5- in TS 36.101 [7]. | | |

Table 7.3A-2: Reference sensitivity for HD-FDD UE category M1 QPSK PREFSENS

|  |  |  |
| --- | --- | --- |
| NTN Band | REFSENS (dBm) | Duplex Mode |
| 253 | -103.5 | HD-FDD |
| 254 | -103.1 | HD-FDD |
| 255 | -103.5 | HD-FDD |
| 256 | -103 | HD-FDD |
| NOTE 1: The transmitter shall be set to PUMAX as defined in subclause 6.2.5 in TS 36.101 [7]. | | |

The reference receive sensitivity (REFSENS) requirement specified in Table 7.3A-1/Table 7.3A-2 shall be met for an uplink transmission bandwidth less than or equal to that specified in Table 7.3A-3.

NOTE: Table 7.3A-3 is intended for conformance tests and does not necessarily reflect the operational conditions of the network, where the number of uplink and downlink allocated resource blocks will be practically constrained by other factors. Typical receiver sensitivity performance with HARQ retransmission enabled and using a residual BLER metric relevant for e.g. Speech Services is given in the Annex [G] (informative).

Table 7.3A-3: FDD UE category M1 Uplink configuration for reference sensitivity

|  |  |  |
| --- | --- | --- |
| E-UTRA Band | NRB | Duplex Mode |
| 253 | 61 | FDD and HD-FDD |
| 254 | 61 | FDD and HD-FDD |
| 255 | 61 | FDD and HD-FDD |
| 256 | 61 | FDD and HD-FDD |
| NOTE 1: 1 refers to the UL resource blocks shall be located as close as possible to the downlink operating band but confined within the transmission bandwidth configuration for the channel bandwidth (Table 5.3A-1). | | |

## 7.3B Reference sensitivity power level for UE category NB1 and NB2

The reference sensitivity power level REFSENS is the minimum mean power applied to the single antenna port for UE category NB1 and category NB2, at which the throughput shall meet or exceed the requirements for the specified reference measurement channel.

The throughput for the REFSENS test is measured based on the Transmission Mode 1 unless specified otherwise.

The category NB1 and NB2 UE throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel as specified in TS 36.101 [7] Annex A.3.2 with received signal level as specified in Table 7.3B-1. Requirement in Table 7.3B-1 applies for any uplink configuration.

Table 7.3B-1: Reference sensitivity for UE category NB1 and NB2

|  |  |
| --- | --- |
| Operating band | REFSENS [dBm] |
| According to subclause 5.2B | - 108.2 |

## 7.4 Maximum input level

This clause is reserved.

## 7.4A Maximum input level for category M1

This is defined as the maximum mean power received at the UE antenna port, at which the specified relative throughput shall meet or exceed the minimum requirements for the specified reference measurement channel.

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in TS 36.101 [7] Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD as described in TS 36.101 [7] Annex A.5.1.1) with parameters specified in Table 7.4A-1.

Table 7.4A-1: Maximum input level

|  |  |  |
| --- | --- | --- |
| Rx Parameter | Units | Channel bandwidth |
| 1.4 MHz |
| Power in Transmission Bandwidth Configuration | dBm | -402 |
| NOTE 1: The transmitter shall be set to 4dB below PCMAX\_L at the minimum uplink configuration specified in Table 7.3A-3 with PCMAX\_L as defined in subclause 6.2.5 of TS 36.101 [7].  NOTE 2: Reference measurement channel is TS 36.101 [7] Annex A.3.2: 64QAM, R=3/4 variant with one sided dynamic OCNG Pattern OP.1 FDD as described in Annex A.5.1.1 of TS 36.101 [7]. | | |

## 7.4B Maximum input level for category NB1 and NB2

This is defined as the maximum mean power received at the UE antenna port, at which the specified relative throughput shall meet or exceed the minimum requirements for the specified reference measurement channel.

Category NB1 and NB2 UE maximum input level requirement is -40 dBm. For this input level the throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel as specified in Annex A.3.2 of TS 36.101 [7].

## 7.5 Adjacent Channel Selectivity (ACS)

This clause is reserved.

## 7.5A Adjacent Channel Selectivity for category M1

Adjacent Channel Selectivity (ACS) is a measure of a receiver's ability to receive a E-UTRA signal at its assigned channel frequency in the presence of an adjacent channel signal at a given frequency offset from the centre frequency of the assigned channel. ACS is the ratio of the receive filter attenuation on the assigned channel frequency to the receive filter attenuation on the adjacent channel(s).

The UE shall fulfil the minimum requirement specified in Table 7.5A-1 for all values of an adjacent channel interferer up to –40 dBm. However it is not possible to directly measure the ACS, instead the lower and upper range of test parameters are chosen in Table 7.5A-2 and Table 7.5A-3 where the throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in TS 36.101 [7] Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD for the DL-signal as described in TS 36.101 [7] Annex A.5.1.1). For operating bands with an unpaired DL part (as noted in Table 5.5-1), the requirements only apply for carriers assigned in the paired part.

Table 7.5A-1: Adjacent channel selectivity

|  |  |  |
| --- | --- | --- |
|  |  | Channel bandwidth |
| Rx Parameter | Units | 1.4 MHz |
| ACS | dB | 33.0 |

Table 7.5A-2: Test parameters for Adjacent channel selectivity, Case 1

|  |  |  |
| --- | --- | --- |
| Rx Parameter | Units | Channel bandwidth |
| 1.4 MHz |
| Power in Transmission Bandwidth Configuration | dBm | REFSENS + 14 dB |
| PInterferer | dBm | REFSENS +45.5dB |
| BWInterferer | MHz | 1.4 |
| FInterferer (offset) | MHz | 1.4+0.0025  /  -1.4-0.0025 |
| NOTE 1: The transmitter shall be set to 4dB below PCMAX\_L at the minimum uplink configuration specified in Table 7.3A-3 with PCMAX\_L as defined in subclause 6.2.5 of TS 36.101 [7].  NOTE 2: The interferer consists of the Reference measurement channel specified in TS 36.101 [7] Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD as described in Annex A.5.1.1 and set-up according to Annex C.3.1.  NOTE 3: For DL category M1 UE, the reference sensitivity for category M1 in table 7.3A-1 should be used as REFSENS for the power in Transmission Bandwidth Configuration.  NOTE 4: For DL category M1 UE, the parameters for the applicable channel bandwidth apply. | | |

Table 7.5A-3: Test parameters for Adjacent channel selectivity, Case 2

|  |  |  |
| --- | --- | --- |
| Rx Parameter | Units | Channel bandwidth |
| 1.4 MHz |
| Power in Transmission Bandwidth Configuration | dBm | -71.5 |
| PInterferer | dBm | -40 |
| BWInterferer | MHz | 1.4 |
| FInterferer (offset) | MHz | 1.4+0.0025  /  -1.4-0.0025 |
| NOTE 1: The transmitter shall be set to 24dB below PCMAX\_L at the minimum uplink configuration specified in Table 7.3A-3 with PCMAX\_L as defined in subclause 6.2.5 of TS 36.101 [7].  NOTE 2: The interferer consists of the Reference measurement channel specified in TS 36.101 [7] Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD as described in Annex A.5.1.1 and set-up according to Annex C.3.1. | | |

## 7.5B Adjacent Channel Selectivity for category NB1 and NB2

Adjacent Channel Selectivity (ACS) is a measure of a receiver's ability to receive a E-UTRA signal at its assigned channel frequency in the presence of an adjacent channel signal at a given frequency offset from the centre frequency of the assigned channel. ACS is the ratio of the receive filter attenuation on the assigned channel frequency to the receive filter attenuation on the adjacent channel(s).

Category NB1 and NB2 UE shall fulfil the minimum requirement specified in Table 7.5B-1 for all values of an adjacent channel interferer up to -40 dBm. However it is not possible to directly measure the ACS, instead the lower and upper range of test parameters are chosen in Table 7.5B-1 where the throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel as specified in TS 36.101 [7] Annex A.3.2.

Table 7.5B-1: Adjacent channel selectivity parameters for category NB1 and NB2

|  |  |  |
| --- | --- | --- |
| ACS1 test Parameters | | |
| Interferer | GSM (GMSK) | E-UTRA |
| Category NB1 or NB2 signal power  (Pwanted ) / dBm | REFSENS + 14 dB | |
| Interferer signal power  (PInterferer ) / dBm | REFSENS + 42 dB | REFSENS + 47 dB |
| Interferer bandwidth | 200 kHz | 5 MHz |
| Interferer offset from category NB1 or NB2 channel edge | ±200 kHz | ±2.5 MHz |
| ACS2 test Parameters | | |
| Interferer | GSM (GMSK) | E-UTRA |
| Category NB1 or NB2 signal power  (Pwanted ) / dBm | -68 dBm | -73 dBm |
| Interferer signal power  (PInterferer ) / dBm | -40 dBm | |
| Interferer bandwidth | 200 kHz | 5 MHz |
| Interferer offset from category NB1 or NB2 channel edge | ±200 kHz | ±2.5 MHz |

## 7.6 Blocking characteristics

This clause is reserved.

Editor’s note: the additional blocking requirements for band 253 will be introduced following further feedback from ETSI and additional studies.

## 7.6A Blocking characteristics for category M1

### 7.6A.1 General

The blocking characteristic is a measure of the receiver's ability to receive a wanted signal at its assigned channel frequency in the presence of an unwanted interferer on frequencies other than those of the spurious response or the adjacent channels, without this unwanted input signal causing a degradation of the performance of the receiver beyond a specified limit. The blocking performance shall apply at all frequencies except those at which a spurious response occur.

### 7.6A.2 In-band blocking requirements for category M1

In-band blocking is defined for an unwanted interfering signal falling into the UE receive band or into the first 15 MHz below or above the UE receive band at which the relative throughput shall meet or exceed the minimum requirement for the specified measurement channels.

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in TS 36.101 [7] Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD for the DL-signal as described in TS 36.101 [7] Annex A.5.1.1) with parameters specified in Tables 7.6A.2-1 and 7.6A.2-2. For operating bands with an unpaired DL part (as noted in Table 5.2A-1), the requirements only apply for carriers assigned in the paired part.

Table 7.6A.2-1: In band blocking parameters

|  |  |  |
| --- | --- | --- |
| Rx parameter | Units | Channel bandwidth |
| 1.4 MHz |
| Power in Transmission Bandwidth Configuration | dBm | REFSENS + channel bandwidth specific value below |
| 6 |
| BWInterferer | MHz | 1.4 |
| FIoffset, case 1 | MHz | 2.1+0.0125 |
| FIoffset, case 2 | MHz | 3.5+0.0075 |
| NOTE 1: The transmitter shall be set to 4dB below PCMAX\_L at the minimum uplink configuration specified in Table 7.3A-3 with PCMAX\_L as defined in subclause 6.2.5 of TS 36.101 [7].  NOTE 2: The interferer consists of the Reference measurement channel specified in TS 36.101 [7] Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD as described in Annex A.5.1.1 and set-up according to Annex C.3.1.  NOTE 3: For DL category M1 UE, the reference sensitivity for category M1 in table 7.3A-1 should be used as REFSENS for the power in Transmission Bandwidth Configuration.  NOTE 4: For DL category M1 UE, the parameters for the applicable channel bandwidth apply. | | |

Table 7.6A.2-2: In-band blocking

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| E-UTRA band | Parameter | Unit | Case 1 | Case 2 |
| PInterferer | dBm | -56 | -44 |
| FInterferer (offset) | MHz | =-BW/2 – FIoffset,case 1  &  =+BW/2 + FIoffset,case 1 | ≤-BW/2 – FIoffset,case 2  &  ≥+BW/2 + FIoffset,case 2 |
| 256, 255, 254, 253 | FInterferer | MHz | (NOTE 2) | FDL\_low – 15  to  FDL\_high + 15 |
| NOTE 1: For certain bands, the unwanted modulated interfering signal may not fall inside the UE receive band, but within the first 15 MHz below or above the UE receive band  NOTE 2: For each carrier frequency the requirement is valid for two frequencies:  a. the carrier frequency -BW/2 - FIoffset, case 1 and  b. the carrier frequency +BW/2 + FIoffset, case 1  NOTE 3: FInterferer range values for unwanted modulated interfering signal are interferer center frequencies | | | | |

### 7.6A.3 Out-of-band blocking requirements for category M1

Out-of-band band blocking is defined for an unwanted CW interfering signal falling more than 15 MHz below or above the UE receive band. For the first 15 MHz below or above the UE receive band the appropriate in-band blocking or adjacent channel selectivity in subclause 7.5A and subclause 7.6A.2 shall be applied.

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in TS 36.101 [7] Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD for the DL-signal as described in TS 36.101 [7] Annex A.5.1.1) with parameters specified in Tables 7.6A.3-1 and 7.6A.3-2.

Table 7.6A.3-1: Out-of-band blocking parameters for category M1 UE

|  |  |  |
| --- | --- | --- |
| RX parameter | Units | Channel bandwidth (MHz) |
|  |  | 1.4 |
| Power in transmission bandwidth configuration | dBm | REFSENS + 6 dB |
| NOTE 1: The transmitter shall be set to 4dB below PCMAX\_L at the minimum uplink configuration specified in Table 7.3.1-2 in TS 36.101 [7] with PCMAX\_L as defined in subclause 6.2.5. | | |

Table 7.6A.3-2: Out of-band blocking for category M1 UE

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Operating Band | Parameter | Unit | Range 1 | Range 2 | Range 3 |
|  | Pinterferer | dBm | -44 | -30 | -15 |
| 253, 2542, 255 | Finterferer (C`W) | MHz | -60 < f – FDL\_low < -15  or  15 < f – FDL\_high < 60 | -85 < f – FDL\_low ≤ -60  or  60 ≤ f – FDL\_high < 85 | 1 ≤ f ≤ FDL\_low – 85  or  FDL\_high + 85 ≤ f  ≤ 12750 |
| 2561 | Finterferer (CW) | MHz | -100 < f – FDL\_low < -15  or  15 < f – FDL\_high < 60 | -145 < f – FDL\_low ≤ -100  or  60 ≤ f – FDL\_high < 85 | 1 ≤ f ≤ FDL\_low – 145  or  FDL\_high + 85 ≤ f  ≤ 12750 |
| NOTE 1: Band 256 lower frequency ranges are modified to enable specific implementations.  NOTE 2: The power level of the interferer (Pinterferer) for Range 3 shall be modified to -20 dBm for Finterferer > 2585 MHz and FInterferer < 2775 MHz. | | | | | |

For Table 7.6A.3-2 in frequency range 1, 2 and 3, up to exceptions are allowed for spurious response frequencies in each assigned frequency channel when measured using a 1MHz step size, where  is the number of resource blocks in the downlink transmission bandwidth configuration. For these exceptions the requirements of subclause 7.7A spurious response are applicable.

### 7.6A.4 Narrow band blocking for category M1

This requirement is measure of a receiver's ability to receive a E-UTRA signal at its assigned channel frequency in the presence of an unwanted narrow band CW interferer at a frequency, which is less than the nominal channel spacing.

The relative throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in TS 36.101 [7] Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD for the DL-signal as described in TS 36.101 [7] Annex A.5.1.1) with parameters specified in Table 7.6A.4-1. For operating bands with an unpaired DL part (as noted in Table 5.2-1), the requirements only apply for carriers assigned in the paired part.

Table 7.6A.4-1: Narrow-band blocking

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Channel Bandwidth |
| 1.4 MHz |
| Pw | dBm | PREFSENS + channel-bandwidth specific value below |
| 22 |
| Puw (CW) | dBm | -55 |
| Fuw (offset for  *f* = 15 kHz) | MHz | 0.9075 |
| Fuw (offset for**  *f* = 7.5 kHz) | MHz |  |
| NOTE 1: The transmitter shall be set a 4 dB below PCMAX\_L at the minimum uplink configuration specified in Table 7.3A-3 with PCMAX\_L as defined in subclause 6.2.5 of TS 36.101 [7].  NOTE 2: Reference measurement channel is specified in TS 36.101 [7] Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD as described in Annex A.5.1.1 of TS 36.101 [7].  NOTE 3: For DL category M1 UE, the reference sensitivity for category M1 in table 7.3A-1 should be used as PREFSENS for Pw.  NOTE 4: For DL category M1 UE, the parameters for the applicable channel bandwidth apply.  NOTE 5: For DL category M1 UE, the parameter, Pw, for all the channel bandwidth will be PREFSENS +22 dBm. | | |

## 7.6B Blocking characteristics for category NB1 and NB2

### 7.6B.1 General

The blocking characteristic is a measure of the receiver's ability to receive a wanted signal at its assigned channel frequency in the presence of an unwanted interferer on frequencies other than those of the spurious response or the adjacent channels, without this unwanted input signal causing a degradation of the performance of the receiver beyond a specified limit. The blocking performance shall apply at all frequencies except those at which a spurious response occur.

### 7.6B.2 In-band blocking requirements for category NB1 and NB2

In-band blocking is defined for an unwanted interfering signal falling into the UE receive band or into the first 15 MHz below or above the UE receive band at which the relative throughput shall meet or exceed the minimum requirement for the specified measurement channels.

For category NB1 and NB2 UE, the requirements in clause 7.6.1.1F of TS 36.101 [7] shall apply.

### 7.6B.3 Out-of-band blocking requirements for category NB1 and NB2

For the first 15 MHz below or above the UE receive band the appropriate in-band blocking or adjacent channel selectivity in subclause 7.5B and subclause 7.6B.2 shall be applied.

The category NB1 and NB2 UE throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in TS 36.101 [7] Annexes A.3.2 with parameters specified in Table 7.6B.3-1.

For Table 7.6B.3-1 in frequency range 1, 2 and 3, up to 24 exceptions are allowed for spurious response frequencies in each assigned frequency channel when measured using a 1MHz step size. For these exceptions the requirements of subclause 7.7B spurious response are applicable.

Table 7.6B.3-1: Out-of-band blocking parameters for category NB1 and NB2 UE

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Operating Band | Parameter | Unit | Range 1 | Range 2 | Range 3 |
| Pw | dBm | REFSENS + 6 dB | | |
| Pinterferer | dBm | -44 | -30 | -153 |
| 253, 2545, 255 | Finterferer (CW) | MHz | -60 < f – FDL\_low < -15  or  15 < f – FDL\_high < 60 | -85 < f – FDL\_low ≤ -60  or  60 ≤ f – FDL\_high < 85 | 1 ≤ f ≤ FDL\_low – 85  or  FDL\_high + 85 ≤ f  ≤ 12750 |
| 2562 | Finterferer (CW) | MHz | -100 < f – FDL\_low < -15  or  15 < f – FDL\_high < 60 | -145 < f – FDL\_low ≤ -100  or  60 ≤ f – FDL\_high < 85 | 1 ≤ f ≤ FDL\_low – 145  or  FDL\_high + 85 ≤ f  ≤ 12750 |
| NOTE 1: Void.  NOTE 2: Band 256 lower frequency ranges are modified to enable specific implementations.  NOTE 3: For operating bands which downlink band frequency range is between 1475.9 MHz < f < 2690 MHz the power level of the interferer (PInterferer) for Range 3 shall be modified to: -20 dBm for the frequency range which is bounded by FDL\_low- 200 MHz of the lowest band that UE supports in frequency range 1475.9 MHz < f < 2690 MHz and FDL\_high + 200 MHz of the highest band that UE supports in frequency range 1475.9 MHz < f < 2690 MHz.”  NOTE 4: The power level of the interferer (PInterferer) for Range 3 shall be modified to -20 dBm for FInterferer > 2800 MHz and FInterferer < 4400 MHz.  NOTE 5: The power level of the interferer (Pinterferer) for Range 3 shall be modified to -20 dBm for Finterferer > 2585 MHz and FInterferer < 2775 MHz. | | | | | |

### 7.6B.4 Narrow band blocking for category NB1 and NB2

For category NB1 and NB2 UE, this is not applicable.

## 7.7 Spurious response

This clause is reserved.

## 7.7A Spurious response for category M1

Spurious response is a measure of the receiver's ability to receive a wanted signal on its assigned channel frequency without exceeding a given degradation due to the presence of an unwanted CW interfering signal at any other frequency at which a response is obtained i.e. for which the out of band blocking limit as specified in subclause 7.6A.2 is not met.

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in TS 36.101 [7] Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD for the DL-signal as described in TS 36.101 [7] Annex A.5.1.1) with parameters specified in Tables 7.7A-1 and 7.7A-2.

Table 7.7A-1: Spurious response parameters

|  |  |  |
| --- | --- | --- |
| Rx parameter | Units | Channel bandwidth |
| 1.4 MHz |
| Power in Transmission Bandwidth Configuration | dBm | REFSENS + channel bandwidth specific value below |
| 6 |
| NOTE 1: The transmitter shall be set to 4dB below PCMAX\_L at the minimum uplink configuration specified in Table 7.3A-3 with PCMAX\_L as defined in subclause 6.2.5 of TS 36.101 [7].  N OTE 2: Reference measurement channel is specified in TS 36.101 [7] Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD as described in Annex A.5.1.1 of TS 36.101 [7].  NOTE 3: The REFSENS power level is specified in Table 7.3A-1. | | |

Table 7.7A-2: Spurious response

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Level |
| PInterferer  (CW) | dBm | -44 |
| FInterferer | MHz | Spurious response frequencies |

## 7.7B Spurious response for category NB1 and NB2

Spurious response is a measure of the receiver's ability to receive a wanted signal on its assigned channel frequency without exceeding a given degradation due to the presence of an unwanted CW interfering signal at any other frequency at which a response is obtained i.e. for which the out of band blocking limit as specified in subclause 7.6B.3 is not met.

For category NB1 and NB2 UE, the minimum requirements in clause 7.7.1F of TS 36.101 [7] shall apply.

## 7.8 Intermodulation characteristics

Intermodulation response rejection is a measure of the capability of the receiver to receiver a wanted signal on its assigned channel frequency in the presence of two or more interfering signals which have a specific frequency relationship to the wanted signal.

## 7.8A Intermodulation characteristics for category M1

The definition in clause 7.8 shall apply. The wide band intermodulation requirement is defined following the same principles using modulated E-UTRA carrier and CW signal as interferer.

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in TS 36.101 [7] Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD for the DL-signal as described in TS 36.101 [7] Annex A.5.1.1) with parameters specified in Table 7.8A.1 for the specified wanted signal mean power in the presence of two interfering signals.

Table 7.8A-1: Wide band intermodulation

|  |  |  |
| --- | --- | --- |
| Rx Parameter | Units | Channel bandwidth |
| 1.4 MHz |
| Power in Transmission Bandwidth Configuration | dBm | REFSENS + channel bandwidth specific value below |
| 12 |
| PInterferer 1  (CW) | dBm | -46 |
| PInterferer 2  (Modulated) | dBm | -46 |
| BWInterferer 2 |  | 1.4 |
| FInterferer 1  (Offset) | MHz | -BW/2 –2.1  /  +BW/2+ 2.1 |
| FInterferer 2  (Offset) | MHz | 2\*FInterferer 1 |
| NOTE 1: The transmitter shall be set to 4dB below PCMAX\_L at the minimum uplink configuration specified in Table 7.3A-3 with PCMAX\_L as defined in subclause 6.2.5 of TS 36.101 [7].  NOTE 2: Reference measurement channel is specified in TS 36.101 [7] Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD as described in Annex A.5.1.1 of TS 36.101 [7].  NOTE 3: The modulated interferer consists of the Reference measurement channel specified in TS 36.101 [7] Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD as described in Annex A.5.1.1 with set-up according to Annex C.3.1.  NOTE 4: For DL category M1 UE, the reference sensitivity for category M1 in table 7.3A-1 should be used as REFSENS for the power in Transmission Bandwidth Configuration.  NOTE 5: For DL category M1 UE, the parameters for the applicable channel bandwidth apply, and BW refers to the corresponding channel bandwidth. | | |

## 7.8B Intermodulation characteristics for category NB1 and NB2

For category NB1 and NB2 UE, the definition in clause 7.8 and the requirements in clause 7.8.1F of TS 36.101 [7] shall apply.

## 7.9 Spurious emissions

The spurious emissions power is the power of emissions generated or amplified in a receiver that appear at the UE antenna connector.

The spurious emissions requirements in clause 7.9.1 of TS 36.101 [7] shall apply.

# 8 Performance requirement

This clause contains performance requirements for the physical channels specified in TS 36.211 [3]. The performance requirements for the UE in this clause are specified for the measurement channels specified in Annex A, the propagation conditions in Annex D and the downlink channels in Annex B.

## 8.1 General

### 8.1.1 Receiver antenna capability

The performance requirements are based on UE(s) that utilize one or more antenna receivers.

For all test cases, the SNR is defined as



where *NRX* denotes the number of receiver antenna connectors and the superscript receiver antenna connector *j*. The above SNR definition assumes that the REs are not precoded. The SNR definition does not account for any gain which can be associated to the precoding operation. The relative power of physical channels transmitted is defined in Annex C. The SNR requirement applies for the UE categories given for each test.

### 8.1.2 Applicability of requirements

#### 8.1.2.1 Applicability of requirements for different channel bandwidths

In Clause 8 the test cases may be defined with different channel bandwidth to verify the same target FRC conditions with the same propagation conditions, correlation matrix and antenna configuration.

#### 8.2.1.2 Applicability of requirements for optional UE features

The performance requirements in Table 8.2.1.2-1 shall apply for UEs which support optional UE features only. If same test is listed for different UE features/capabilities in Clauses 8.2.1.2, then this test shall apply for UEs which support all corresponding UE features/capabilities.

Table 8.2.1.2-1: Requirements applicability for optional UE features

|  |  |  |
| --- | --- | --- |
| UE feature/capability | Test list | Applicability notes |
| NTN access (ntn-Connectivity-EPC-r17) | Clause 8.2.1.1 (Test 1, Test 2, Test 3) | The requirements apply only for UE Category M1 |
| Clause 8.3.1.1 (Test 1, Test 2) | The requirements apply only for UE Category NB1, NB2 |
| NTN scenario support (ntn-ScenarioSupport-r17) | Clause 8.2.1.1 (Test 1, Test 2, Test 3) | The requirements apply only for UE Category M1, and only when ntn-ScenarioSupport-r17 is “ngso” or is not included |
| Clause 8.3.1.1 (Test 1, Test 2) | The requirements apply only for UE Category NB1, NB2, and only when ntn-ScenarioSupport-r17 is “ngso” or is not included |
| Operation in coverage enhancement mode A (ce-ModeA-r13) | Clause 8.2.1.1 (Test 1, Test 2) | The requirements apply only for UE Category M1 |
| Operation in coverage enhancement mode B (ce-ModeB-r13) | Clause 8.2.1.1 (Test 3) | The requirements apply only for UE Category M1 |
| Note: For UE supports NTN access (*ntn-Connectivity-EPC-r17*), the requirements in TS36.101 Clause 8 and Clause 9 also applies to UE according to the UE category and capability | | |

### 8.1.3 UE category and UE DL category

UE category and UE DL category refer to *ue-Category,* *ue-CategoryDL, and ue-Category-NB* define in 4.1, 4.1A and 4.1C from [11]. A UE that belongs to either a UE category or a UE DL category indicated in UE performance requirements in subclause 8 shall fulfil the corresponding requirements.

## 8.2 Demodulation performance requirements for UE category M1

The requirements for UE DL Category M1 in this sub-clause are defined based on the simulation results with UE DL Category M1 unless otherwise stated.

### 8.2.1 FDD and half-duplex FDD

#### 8.2.1.1 PDSCH

The parameters specified in Table 8.2.1.1-1 are valid for FDD and half-duplex FDD tests unless otherwise stated.

Table 8.2.1.1-1: Common Test Parameters (FDD and half-duplex FDD)

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Unit | CE Mode A | CE Mode B |
| Inter-TTI Distance |  | 1 | 1 |
| Number of HARQ processes per component carrier | Processes | 8 | 2 |
| Maximum number of HARQ transmission |  | 4 | 4 |
| Redundancy version coding sequence *rvidx* (Note 1) |  | {0, 2, 3, 1} for QPSK and 16QAM | {0,0,0,0,2,2,2,2,3,3,3,3,1,1,1,1…} for QPSK |
| Cyclic Prefix |  | Normal | Normal |
| Beamforming Precoder for MPDCCH |  | N/A | N/A |
| BL/CE DL subframe comfiguration (fdd-DownlinkOrTddSubframeBitmapBR) |  | 1111111111 | 1111111111 |
| HARQ bundling(ce-HARQ-AckBundling) |  | Disabled | Disabled |
| Koffset (k-Offset) | ms | 8 | 8 |
| Note 1: *rvidx* is defined in TS 36.213 [12] Table 7.1.7.1-2. | | | |

##### 8.2.1.1.1 Single-antenna port performance

8.2.1.1.1.1 Minimum Requirements

The requirements are specified in Table 8.2.1.1.1.1-2, with the addition of the parameters in Table 8.2.1.1.1.1-1, and the downlink physical channel setup according to Annex B.3.2. The purpose is to verify the performance of single antenna port configuration.

Table 8.2.1.1.1.1-1: Test Parameters for single antenna port (FRC)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameter | | Unit | Test 1 | Test 2 | Test 3 |
| Downlink power allocation |  |  | -3 | -3 | -3 |
|  |  |  | -3 (Note 1) | -3 (Note 1) | -3 (Note 1) |
|  |  |  | 0 | 0 | 0 |
|  |  |  | 3 | 3 | 3 |
| at antenna port | | dBm/15kHz | -98 | -98 | -98 |
| Coverage enhancement mode | |  | CE Mode A | CE Mode A | CE Mode B |
| PDSCH transmission mode | |  | 1 | 1 | 1 |
| OFDM starting symbol (startSymbolBR) | |  | 2 | 2 | 2 |
| Maximum number of repetitions  (for PDSCH (*pdsch-maxNumRepetitionCEmodeA/ pdsch-maxNumRepetitionCEmodeB*)) | |  | Not configured | Not configured | Not configured |
| PDSCH repetition number | |  | 1 | 8 | 64 |
| Frequency hopping  (mpdcch-pdsch-HoppingConfig) | |  | Disabled | Disabled | Disabled |
| Frequency hopping offset  (mpdcch-pdsch-HoppingOffset) | |  | N/A | N/A | N/A |
| Frequency hopping interval  (interval-FDD) | | ms | N/A | N/A | N/A |
| MPDCCH transmission duration  (mPDCCH-NumRepetition) | | ms | 1 | 8 | 64 |
| MPDCCH repetition number | |  | 1 | 8 | 64 |
| Number of narrowbands for frequency hopping  (mpdcch-pdsch-HoppingNB) | |  | N/A | N/A | N/A |
| Starting subframe configuration for MPDCCH  (mpdcch\_startSF\_UESS) | |  | 1 | 4 | 2.5 |
| Narrowband for MPDCCH  (mpdcch\_Narrowband) | |  | 0 | 0 | 0 |
| MPDCCH aggregation level | |  | 8 | 24 | 24 |
| Note 1: .  Note 2: For each test, DC subcarrier puncturing shall be considered.  Note 3: If not otherwise stated, the values in this table refer to parameters in TS 36.211 [3] or/and TS 36.213 [12] as appropriate. | | | | | |

Table 8.2.1.1.1.1-2: Minimum performance for single antenna port (FRC)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Test number | Bandwidth and MCS | Reference Channel | OCNG Pattern | Propagation Condition | Correlation Matrix and Antenna Configuration | Reference value | | UE Category |
| Fraction of Maximum  Throughput (%) | SNR (dB) |
| 1 | 1.4MHz 16QAM 1/2 | R.1 FDD | OP.1 FDD | NTN-TDLC5-30 | 1x1 | 70 | 10.4 | M1 |
| 2 | 1.4MHz QPSK 1/3 | R.2 FDD | OP.1 FDD | NTN-TDLA100-200 | 1x1 | 70 | -4.2 | M1 |
| 3 | 1.4MHz QPSK 1/10 | R.3 FDD | OP.1 FDD | NTN-TDLA100-10 | 1x1 | 70 | -11.5 | M1 |

## 8.3 Demodulation performance requirements for UE category NB1 and NB2

### 8.3.1 Half-duplex FDD

#### 8.3.1.1 NPDSCH demodulation requirements

The parameters specified in Table 8.3.1.1-1 and Table 8.3.1.1-2 are valid for all half-duplex FDD tests unless otherwise stated.

Table 8.3.1.1-1: Common Test Parameters

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Value |
| Number of HARQ processes per component carrier | Processes | 1 |
| Maximum number of HARQ transmission |  | 4 |
| Cyclic Prefix |  | Normal |
| eutraControlRegionSize-r13 |  | N/A |
| downlinkBitmap-r13 and dl-Gap-r13 |  | Not configured |
| dl-GapNonAnchor-r13 and  downlinkBitmapNonAnchor-r13 |  | Not configured |
| Unused REs or RB |  | OCNG |
| OCNG pattern |  | NB.OP.1 |

Table 8.3.1.1-2: Test Parameters of related NPDCCH and NPUSCH format 2 configurations

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Value |
| DCI format |  | DCI format N1 |
| scheduling delay field () |  | 1 |
| **(***ack-NACK-NumRepetitions-r13*) |  | 1 |
| ACK/NACK resource field |  | 0 |
| Reference channel for NPDCCH |  | R.NB.3 FDD |
| (*npdcch-Offset-USS-r13*) |  | 0 |
| K\_offset | ms | 8 |

##### 8.3.1.1.1 Single-antenna port performance

8.3.1.1.1.1 Minimum Requirements for standalone

The requirements are specified in Table 8.3.1.1.1.1-2, with the addition of the parameters in Table 8.3.1.1.1.1-1 and the downlink physical channel setup according to Annex B.3.3. The purpose of these tests is to verify the performance.

Table 8.3.1.1.1.1-1: Test Parameters for NPDSCH under Standalone

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Unit | | Test 1, 2 |
| at antenna port |  | dBm/15kHz | -93 (Note 1) |
|  | dBm/15kHz | -99 (Note 2) |
| NPDCCH repetition number | | subframe | 32 for Test 1; 128 for Test 2. |
| (*npdcch-NumRepetitions-r13*) | | subframe | 64 for Test 1; 256 for Test 2. |
| (*nPDCCH-startSF-USS-r13*) | |  | 1.5 |
| Note 1: This noise is applied to all subframes from the end of the NPDCCH to the end of the following NPDSCH transmission.  Note 2: This noise is applied to all subframes from the end of the NPDSCH to the end of the following NPDCCH transmission. | | | |

Table 8.3.1.1.1.1-2: Minimum performance for NPDSCH under Standalone with 1 NRS port

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Test number | Bandwidth | Carrier Type | Reference Channel | Repetition number | Propagation condition | Number of NRS ports | Antenna Configuration | Reference value | | UE Category |
| **Fraction of Maximum**  **Throughput (%)** | **SNR (dB)** |
| 1 | 200kHz | Anchor | R.NB.1 FDD | 32 | NTN-TDLC5-200 | 1 | 1x1 | 70% | -4.7 | NB1, NB2 |
| 2 | 200kHz | Non-anchor | R.NB.2 FDD | 128 | NTN-TDLA100-10 | 1 | 1x1 | 70% | -10.6 | NB1, NB2 |

Annex A (normative):   
Measurement channels

# A.1 DL reference measurement channels

## A.1.1 Reference measurement channels for NPDSCH performance requirements

### A.1.1.1 Standalone

Table A.1.1.1-1: NPDSCH Reference Channel with 1Tx Antenna for UE Category NB1 and NB2 for FDD

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | **Value** |
| Reference channel |  | R.NB.1 FDD | R.NB.2 FDD |
| Carrier Type |  | Anchor | Non-anchor |
| Channel bandwidth | KHz | 200 | 200 |
| Allocated subframes per Radio Frame |  | Note 1 | Note 1 |
| Modulation |  | QPSK | QPSK |
| ITBS/ISF |  | 9/3 | 6/3 |
| Target Coding Rate |  | 1/2 | 1/3 |
| Coding Rate |  | 0.5 | 0.33 |
| Information Bit Payload |  |  |  |
| For Sub-Frames 1,2,3,6,7,8 | Bits | 616 | 392 |
| For Sub-Frame 0,5 | Bits | N/A | 392 |
| For Sub-Frame 4,9 | Bits | Note 2 | 392 |
| Number of Code Blocks |  |  |  |
| For Sub-Frames 1,2,3,6,7,8 |  | 1 | 1 |
| For Sub-Frame 0,5 | Bits | N/A | 1 |
| For Sub-Frame 4,9 | Bits | Note 3 | 1 |
| Binary Channel Bits |  |  |  |
| For Sub-Frames 1,2,3,6,7,8 | Bits | 320 | 320 |
| For Sub-Frame 0,5 | Bits | N/A | 320 |
| For Sub-Frame 4,9 | Bits | Note 4 | 320 |
| Max. Average Throughput | Bps | Note 5 | Note 5 |
| UE Category |  | NB1,NB2 | NB1,NB2 |
| Note 1: It shall depend on the specific NPDSCH scheduling. Note 2: N/A when *n*f mod 2 = 0, otherwise 616.  Note 3: N/A when *n*f mod 2 = 0, otherwise 1.  Note 4: N/A when *n*f mod 2 = 0, otherwise 320.  Note 5: Maximum Average Throughput equals to sum of TB(i) divided by sum of T(i), where TB(i) is the TB size of NPDSCH over ith NPDSCH scheduling period, and T(i) is the total time consisting of NPDCCH transmission duration, NPDCCH to NPDSCH scheduling  delay, NPDSCH transmission duration, NPDSCH to NPUSCH format 2 scheduling delay, NPUSCH format 2 transmission duration, possible delay between NPUSCH format 2 and NPDCCH for next NPDSCH scheduling and subframes used for NPSS/NSSS/NPBCH/NB-  SIB1/NB-SIB2 transmission during the ith NPDSCH scheduling period. | | | |

Table A.1.1.1-2: NPDCCH Reference Channel for Category NB1 and NB2 UE

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Value |
| Reference channel |  | R.NB.3 FDD |
| Number of NRS ports |  | 1 |
| Channel bandwidth | MHz | 0.2 |
| Aggregation level | NCCE | 2 |
| DCI Format |  | N1 |
| Payload (without CRC) | Bits | 23 |

## A.1.2 Reference measurement channels for PDSCH performance requirements

### A.1.2.1 Single-antenna transmission (Common Reference Symbols)

Table A.1.2.1-1: Fixed Reference Channel Single Antenna Port

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Unit | Value | | |
| Reference channel |  | R.1 FDD | R.2 FDD | R.3 FDD |
| Channel bandwidth | MHz | 1.4 | 1.4 | 1.4 |
| Allocated resource blocks |  | Note3 | 6 | 6 |
| Allocated DL subframes per Radio Frame |  | Note 4 | Note 5 | Note 6 |
| Modulation |  | 16QAM | QPSK | QPSK |
| Target Coding Rate |  | 1/2 | 1/3 | 1/10 |
| Information Bit Payload |  |  |  |  |
| For Sub-Frames 0,1,2,3,4,5,6,7,8,9 | Bits | 744 | 504 | 152 |
| Number of Code Blocks |  |  |  |  |
| For Sub-Frames 0,1,2,3,4,5,6,7,8,9 | Code blocks | 1 | 1 | 1 |
| Binary Channel Bits |  |  |  |  |
| For Sub-Frames 0,1,2,3,4,5,6,7,8,9 | Bits | 1656  (Note 7, 8) | 1656  (Note 7, 8) | 1656  (Note 7, 8) |
| Max. Throughput averaged over one period | Kbps | 149 | 15.75 | 0.950 |
| UE DL Category |  | M1 | M1 | M1 |
| Note 1: Void.  Note 2: Reference signal, synchronization signals and PBCH are allocated as per TS 36.211 [3].  Note 3: Allocated PRB positions for PDSCH are {3, 4, 5}.  Note 4: The downlink subframes are scheduled at the 8th and 9th subframes every 10ms (starting from 0th subframe). Information bit payload is available from the 8th to 9th subframes. The corresponding MPDCCH is scheduled 2 subframes before the corresponding PDSCH transmissions.  Note 5: PDSCH subframes are scheduled at the 10th to 17th subframes every period (32ms). Information bit payload is available from the 10th to 17th subframes with repetition. (Starting from the 0th subframe). The corresponding MPDCCH is scheduled from 1st to 8th subframe every 32ms (starting from 0th subframe).  Note 6: PDSCH subframes are scheduled at the 96th to 159th subframes every period (160ms). Information bit payload is available at the 96th to 159th subframes with repetition. (Starting from the 0th subframe) The corresponding MPDCCH is scheduled from 31st to 94th subframe every 160ms (starting from 0th subframe).  Note 7: MPDCCH, and PDSCH are dropped when overlapped with SIB1-BR, or SIB2 or SIB3.  Note 8: MPDCCH, and PDSCH are punctured in overlapping Resource Elements (RE)s with PSS/SSS/PBCH. | | | | |

# A.2 OFDMA Channel Noise Generator (OCNG)

## A.2.1 OCNG Patterns for Narrowband IoT

The following OCNG patterns are used for modelling allocations to virtual narrowband IoT UEs (which are not under test). The OCNG pattern for each sub frame specifies the allocations that shall be filled with OCNG, and furthermore, the relative power level of each such allocation.

In each test case the OCNG is expressed by parameters OCNG\_RA and OCNG\_RB which together with a relative power level () specifies the NPDSCH EPRE-to-NRS EPRE ratios in OFDM symbols with and without Narrowband reference symbols, respectively. The relative power, which is used for modelling boosting per virtual UE allocation, is expressed by:

 i  NPDSCHi \_ RA / OCNG \_ RA  NPDSCHi \_ RB / OCNG \_ RB,

where ** *i* denotes the relative power level of the i:th virtual UE. The parameter settings of OCNG\_RA, OCNG\_RB and the set of relative power levels are chosen such that when also taking allocations to the UE under test into account, as given by a NPDSCH or NPDCCH reference channel, a transmitted power spectral density that is constant on an OFDM symbol basis is targeted.

### A.2.1.1 Narrowband IoT OCNG pattern 1

|  |  |  |
| --- | --- | --- |
| Table A.2.1.1-1: NB.OP.1 FDD: OCNG FDD Pattern 1  Bandwidth | Relative power level ** [dB] | NPDCCH and corresponding NPDSCH  Data |
| Subframe |
| Unused subframes |
| 200KHz | 0 | Note 2 |
| Note 1: These subframes are assigned to an arbitrary number of virtual UEs with one NPDSCH per virtual UE with corresponding NPDCCH; the data transmitted over the OCNG NPDSCHs shall be uncorrelated pseudo random data, which is QPSK modulated. The  parameter ** is used to scale the power of NPDSCH and NPDCCH.  Note 2: Subframes and/or REs available for narrowband IOT DL transmission depend on the in-band, guard band or standalone mode indicated in MIB, and scheduling delay  between NPDCCH, NPDSCH, NPUSCH format 2 and NPDCCH specified in test cases. | | |

## A.2.2 OCNG Patterns for FDD

The following OCNG patterns are used for modelling allocations to virtual UEs (which are not under test) and/or allocations used for MBSFN. The OCNG pattern for each sub frame specifies the allocations that shall be filled with OCNG, and furthermore, the relative power level of each such allocation.

In each test case the OCNG is expressed by parameters OCNG\_RA and OCNG\_RB which together with a relative power level () specifies the PDSCH EPRE-to-RS EPRE ratios in OFDM symbols with and without reference

symbols, respectively. The relative power, which is used for modelling boosting per virtual UE allocation, is expressed by:

 i  NPDSCHi \_ RA / OCNG \_ RA  NPDSCHi \_ RB / OCNG \_ RB,

where ** *i* denotes the relative power level of the i:th virtual UE. The parameter settings of OCNG\_RA, OCNG\_RB and the set of relative power levels are chosen such that when also taking allocations to the UE under test into account, as given by a NPDSCH or NPDCCH reference channel, a transmitted power spectral density that is constant on an OFDM symbol basis is targeted.

Moreover, the OCNG pattern is accompanied by a PCFICH/PDCCH/PHICH reference channel which specifies the control region. For any aggregation and PHICH allocation, the PDCCH and any unused PHICH groups are padded with resource element groups with a power level given respectively by PDCCH\_RA/RB and PHICH\_RA/RB as specified in the test case such that a total power spectral density in the control region that is constant on an OFDM symbol basis is targeted.

### A.2.2.1 OCNG FDD Pattern 1: Two sided dynamic OCNG FDD pattern

This OCNG Pattern fills with OCNG all empty PRB-s (PRB-s with no allocation of data or system information) of the DL sub-frames, when the unallocated area is discontinuous in frequency domain (divided in two parts by the allocated area – two sided), starts with PRB 0 and ends with PRB *NRB* 1.

Table A.2.2.1-1: OP.1 FDD: Two sided dynamic OCNG FDD Pattern

|  |  |  |  |
| --- | --- | --- | --- |
| Relative power level ** *PRB* [dB] | | | PDSCH Data |
| Subframe | | |
| 0 | 5 | 1 – 4, 6 – 9 |
| Allocation | | |
| 0 – (First allocated PRB-1) and  (Last allocated PRB+1) – (  *NRB* 1) | 0 – (First allocated PRB-1) and  (Last allocated PRB+1) – (  *NRB* 1) | 0 – (First allocated PRB-1) and  (Last allocated PRB+1) – (  *NRB* 1) |
| 0 | 0 | 0 | Note 1 |
| Note 1: These physical resource blocks are assigned to an arbitrary number of virtual UEs with one PDSCH per virtual UE; the data transmitted over the OCNG PDSCHs shall be uncorrelated pseudo random data, which is QPSK modulated. The parameter ** *PRB* is used to scale the power of PDSCH. | | | |

# A.3 Testing related to Satellite Access

## A.3.1 General

The following test conditions should be maintained for Satellite Access

- The same ephemeris info will be maintained during each test.

- A set of ephemeris information are pre-defined for each satellite corresponding to respective epoch times in TS 36.508 [14].

- The range of the selected constant delay shift is as follows:

- For NGSO an altitude of 600km and 1200km on a circular orbit are considered. The range of the one-way delay between UE and satellite is from 2ms (lowest value for LEO orbit 600km) to 6.67ms (highest value for LEO orbit 1200km).

- Constant delay value is derived from ephemeris info (SIB31) and UE location associated to zero Doppler or non-zero Doppler value under test.

## A.3.2 Test condition for transmitter characteristics

All requriements in section 6 for transmitter characteristics, other than frequency error in clauses 6.4A.1 and 6.4B.1, shall be verified when Doppler conditions are set to zero and delay conditions are set to constant for all types of satellites.

Frequency error requirement in clauses 6.4A.1 and 6.4B.1 shall be verified for at least two cases: one with zero Doppler condition and the other one with constant Doppler (different from zero) up to [0.93] ppm for GSO satellites and up to 24 ppm for NGSO satellites.

## A.3.3 Test condition for receiver characteristics

All requirements in section 7 for receiver characteristics shall be verified when Doppler conditions related to satellite motion for DL in service link are set to zero and delay conditions are set to constant for all types of satellites.

## A.3.4 Test condition for performance requirements

All requirements in section 8 for performance requirements shall be verified when Doppler conditions related to satellite motion for DL in service link are set to zero and delay conditions are set to constant for all types of NGSO satellites. The one-way delay between UE and satellite for NGSO at an altitude of 600km is 2ms.

Annex B (normative):   
Downlink physical channels

# B.1 General

This annex specifies the downlink physical channels that are needed for setting a connection and channels that are needed during a connection.

# B.2 Set-up

Table B.2-1 and B.2-2 describes the downlink Physical Channels that are required for connection set up.

Table B.2-1: Downlink Physical Channels required  
for connection set-up (Cat-M1)

|  |
| --- |
| Physical Channel |
| PBCH |
| SSS |
| PSS |
| MPDCCH |
| PDSCH |

|  |
| --- |
| Table B.2-2: Downlink Physical Channels required for connection set-up (Cat NB1/NB2)Physical Channel |
| NPBCH |
| NSSS |
| NPSS |
| NPDCCH |
| NPDSCH |

# B.3 Connection

The following clauses, describes the downlink Physical Channels that are transmitted during a connection i.e., when measurements are done.

## B.3.1 Measurement of Receiver Characteristics

Unless otherwise stated, Table B.3.1-1 is applicable for measurements on the Receiver Characteristics (clause 7).

Table B.3.1-1: Downlink Physical Channels transmitted during a connection

|  |  |
| --- | --- |
| Physical Channel | EPRE Ratio |
| PBCH | PBCH\_RA = 0 dB |
| PBCH\_RB = 0 dB |
| PSS | PSS\_RA = 0 dB |
| SSS | SSS\_RA = 0 dB |
| PDSCH | PDSCH\_RA = 0 dB |
| PDSCH\_RB = 0 dB |
| OCNG | OCNG\_RA = 0 dB |
| OCNG\_RB = 0 dB |

NOTE 1: No boosting is applied.

Table B.3.1-2: Power allocation for OFDM symbols and reference signals

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Unit | Value | Note |
| Transmitted power spectral density | dBm/15 kHz | Test specific | 1. shall be kept constant throughout all OFDM symbols |
| Cell-specific reference signal power ratio |  | 0 dB |  |

## B.3.2 Measurement of Performance requirements

Table B.3.2-1 is applicable for measurements in which uniform RS-to-EPRE boosting for all downlink physical channels, unless otherwise stated.

Table B.3.2-1: Downlink Physical Channels transmitted during a connection

|  |  |
| --- | --- |
| Physical Channel | EPRE Ratio |
| PBCH | PBCH\_RA = A+ σ |
| PBCH\_RB = B+ σ |
| PSS | PSS\_RA = 0 (Note 3) |
| SSS | SSS\_RA = 0 (Note 3) |
| MPDCCH | MPDCCH\_RA = A+δ |
| MPDCCH\_RB = B+δ |
| PDSCH | PDSCH\_RA = A |
| PDSCH\_RB = B |
| OCNG | OCNG\_RA = A+ σ |
| OCNG\_RB = B+ σ |

NOTE 1: A= B = 0 dB means no RS boosting.

NOTE 2: OCNG are not defined downlink physical channels in [3].

NOTE 3: Assuming PSS and SSS transmitted on a single antenna port.

NOTE 4: A, B, σ, and δ are test specific.

Table B.3.2-2: Power allocation for OFDM symbols and reference signals

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Unit | Value | Note |
| Total transmitted power spectral density | dBm/15 kHz | Test specific | 1. shall be kept constant throughout all OFDM symbols |
| Cell-specific reference signal power ratio |  | Test specific | 1. Applies for antenna port *p* |
| Energy per resource element EPRE |  | Test specific | 1. The complex-valued symbols and defined in TS 36.211 [3] shall conform to the given EPRE value. |

## B.3.3 Measurement of Receiver Characteristics for Narrowband IoT

For the performance requirements for Narrowband IoT, the power allocation for the physical channels is listed in Table B.3.3-1.

Table B.3.3-1: Downlink Physical Channels transmitted during a connection

|  |  |  |
| --- | --- | --- |
| Physical Channel | EPRE Ratio for one NRS antenna port | EPRE Ratio for two NRS antenna ports |
| NPBCH | 0 dB | -3 dB |
| NPDCCH | 0 dB | -3 dB |
| NPDSCH | 0 dB | -3 dB |
| NPSS | 0 dB | 0 dB |
| NSSS | 0 dB | 0 dB |

NOTE 1: Assuming NPSS and NSSS transmitted on one NRS antenna port.

Table B.3.3-2: Power allocation for OFDM symbols and reference signals

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Unit | Value | Note |
| Transmitted power spectral density | dBm/15 kHz | Test specific | shall be kept constant throughout all OFDM symbols |
| Narrowband reference signal power ratio |  | 0 dB | Applicable for Stand-alone operation |
| Narrowband reference signal power over cell-specific reference signal power |  | 0 dB | Applicable for In-band operation |

Annex C (normative):   
Environment conditions

# C.1 General

This normative annex specifies the environmental requirements of the UE. Within these limits the requirements of the present documents shall be fulfilled.

# C.2 Environmental

The requirements in this clause apply to all types of UE(s).

## C.2.1 Temperature

The UE shall fulfil all the requirements in the full temperature range of:

Table C.2.1-1

|  |  |
| --- | --- |
| +15°C to +35°C | for normal conditions (with relative humidity of 25 % to 75 %) |

Outside this temperature range the UE, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in clause 6.2 of TS 36.101 [7] for extreme operation.

## C.2.2 Voltage

The UE shall fulfil all the requirements in the full voltage range defined in Table C.2.2-1.

Table C.2.2-1

|  |  |
| --- | --- |
| Power source | Normal conditions  voltage |
| AC mains | nominal |
| Regulated lead acid battery | 1,1 \* nominal |
| Non regulated batteries:  Leclanché  Lithium  Mercury/nickel & cadmium | Nominal  1,1 \* Nominal  Nominal |

Outside this voltage range the UE if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in clause 6.2 of TS 36.101 [7] for extreme operation. In particular, the UE shall inhibit all RF transmissions when the power supply voltage is below the manufacturer declared shutdown voltage.

## C.2.3 Vibration

The UE shall fulfil all the requirements when vibrated at the following frequency/amplitudes.

Table C.2.3-1

|  |  |
| --- | --- |
| Frequency | ASD (Acceleration Spectral Density) random vibration |
| 5 Hz to 20 Hz | 0,96 m2/s3 |
| 20 Hz to 500 Hz | 0,96 m2/s3 at 20 Hz, thereafter –3 dB/Octave |

Outside the specified frequency range the UE, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in TS 36.101 [6] for extreme operation.

Annex D (normative):   
Propagation conditions

# D.1 Multi-path fading propagation conditions

The multipath propagation conditions consist of several parts:

- A delay profile in the form of a "tapped delay-line", characterized by a number of taps at fixed positions on a sampling grid. The profile can be further characterized by the r.m.s. delay spread and the maximum delay spanned by the taps.

- A combination of channel model parameters that include the Delay profile and the Doppler spectrum that is characterized by a classical spectrum shape and a maximum Doppler frequency.

## D.1.1 Delay profiles

The delay profiles are derived from the TR 38.811 [13] NTN-TDL models for the desired delay spread and tap resolution. After scaling the normalized delay spread values for each tap by the desired RMS delay spread, the tap delays are quantized to a delay resolution of 5ns by rounding to the nearest multiple of the delay resolution.

Table D.1.1-1: Delay profiles for IoT NTN channel models

|  |  |  |  |
| --- | --- | --- | --- |
| Type | Model | Delay spread (r.m.s.) | Delay resolution |
| NLOS | NTN-TDLA100 | 100 ns | 5 ns |
| LOS | NTN-TDLC5 | 5 ns | 5 ns |

**Table D.1.1-2: NTN-TDLA100 (DS = 100 ns)**

|  |  |  |  |
| --- | --- | --- | --- |
| Tap # | Delay [ns] | Power [dB] | Fading distribution |
| 1 | 0 | 0 | Rayleigh |
| 2 | 110 | -4.7 | Rayleigh |
| 3 | 285 | -6.5 | Rayleigh |

Table D.1.1-3 NTN-TDLC5 (DS = 5 ns)

|  |  |  |  |
| --- | --- | --- | --- |
| Tap # | Delay [ns] | Power [dB] | Fading distribution |
| 1 | 0 | -0.6 | LOS path |
| 0 | -8.9 | Rayleigh |
| 2 | 60 | -21.5 | Rayleigh |
| Note 1: Tap #1 follows a Rician distribution. | | | |

## D.1.2 Combinations of channel model parameters

The propagation conditions used for the performance measurements in multi-path fading environment are indicated as a combination of a channel model name and a maximum Doppler frequency, i.e., NTN-TDLA<DS>-<Doppler>, or NTN-TDLC<DS>-<Doppler> where '<DS>' indicates the desired delay spread and '<Doppler>' indicates the maximum Doppler frequency (Hz).

Table D.1.2-1 show the propagation conditions that are used for the performance measurements in multi-path fading environment for NLOS and LOS propagation conditions.

Table D.1.2-1: Channel model parameters for NTN

|  |  |  |
| --- | --- | --- |
| Combination name | Model | Maximum Doppler frequency |
| NTN-TDLA100-10 | NTN-TDLA100 | 10 Hz |
| NTN-TDLA100-200 | NTN-TDLA100 | 200 Hz |
| NTN-TDLC5-30 | NTN-TDLC5 | 30 Hz |
| NTN-TDLC5-200 | NTN-TDLC5 | 200 Hz |

Annex E (informative):  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Change history | | | | | | | |
| Date | Meeting | TDoc | CR | Rev | Cat | Subject/Comment | New version |
| 2022-08 | RAN4#104-e | R4-2215118 |  |  |  | Initial Skeleton | 0.1.0 |
| 2022-10 | RAN4#105 | R4-2218376 |  |  |  | Added approved TPs in RAN4#104-bis-e including:  R4-2217750, R4-2217752, R4-2217753, R4-2217755, R4-2217807, R4-2217810 | 0.2.0 |
| 2022-11 | RAN4#105 | R4-2218377 |  |  |  | Added approved TPs in RAN4#105 including:  R4-2218767, R4-2220803, R4-2220804, R4-2220805, R4-2220806, R4-2220812, R4-2220828, R4-2220835, R4-2220836 | 0.3.0 |
| 2022-12 | RAN#98-e | RP-223233 |  |  |  | 1-step Approval of version 1.0.0 | 1.0.0 |

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| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2022-12 | RAN#98-e |  |  |  |  | Approved by plenary – Rel-18 spec under change control | 18.0.0 |
| 2023-03 | RAN#99 | RP-230526 | 0001 | 1 | F | Updates to the additional emissions requirements related to NS\_02N | 18.1.0 |
| 2023-03 | RAN#99 | RP-230526 | 0002 | 1 | F | CR to 36.102 for NTN IoT UE RF requirements corrections | 18.1.0 |
| 2023-03 | RAN#99 | RP-230526 | 0003 | 1 | F | CR to 36.102 for MPR and A-MPR | 18.1.0 |
| 2023-03 | RAN#99 | RP-230526 | 0005 | 1 | F | Update A-MPR for NS\_24 for Cat-M1 | 18.1.0 |
| 2023-06 | RAN#100 | RP-231361 | 0008 | 1 | B | Big CR to TS36.102: Introduction of IoT-NTN UE demodulation requirements | 18.2.0 |
| 2023-06 | RAN#100 | RP-231364 | 0009 |  | F | CR to add B54/n54 as protected band and correct reference clause in 6.5B.4.3 | 18.2.0 |
| 2023-06 | RAN#100 | RP-231364 | 0010 |  | F | Correction on Pcmax and OOBB requirement for category NB1/NB2 UE | 18.2.0 |
| 2023-06 | RAN#100 | RP-231364 | 0011 | 1 | F | CR to 36.102 for NTN IoT UE RF requirements corrections | 18.2.0 |
| 2023-09 | RAN#101 | RP-232510 | 0015 |  | F | CR to TS36.102: Corrections to IoT-NTN requirements | 18.3.0 |
| 2023-09 | RAN#101 | RP-232510 | 0018 | 1 | F | CR to remove PC5 for A-MPR table | 18.3.0 |
| 2023-09 | RAN#101 | RP-232510 | 0019 | 1 | F | Clarifications to 36.102 | 18.3.0 |
| 2023-12 | RAN#102 | RP-233355 | 0021 |  | B | CR to TS 36.102 on intrdoucing L+S FDD band for IoT NTN operation | 18.4.0 |
| 2023-12 | RAN#102 | RP-233354 | 0023 | 1 | B | CR to TS36.102 Introduction of the Extended L-band | 18.4.0 |
| 2023-12 | RAN#102 | RP-233357 | 0024 |  | F | Correction of FRC for eMTC UE demodulation requirements | 18.4.0 |
| 2023-12 | RAN#102 | RP-233357 | 0025 |  | F | CR to TS36.102 Addition of downlink physical channels for connection set-up for Cat NB1 and NB2 | 18.4.0 |
| 2023-12 | RAN#102 | RP-233357 | 0026 | 2 | F | [LTE\_NBIoT\_eMTC\_NTN\_req] CR to 36.102 Clarify test condition for IoT NTN | 18.4.0 |